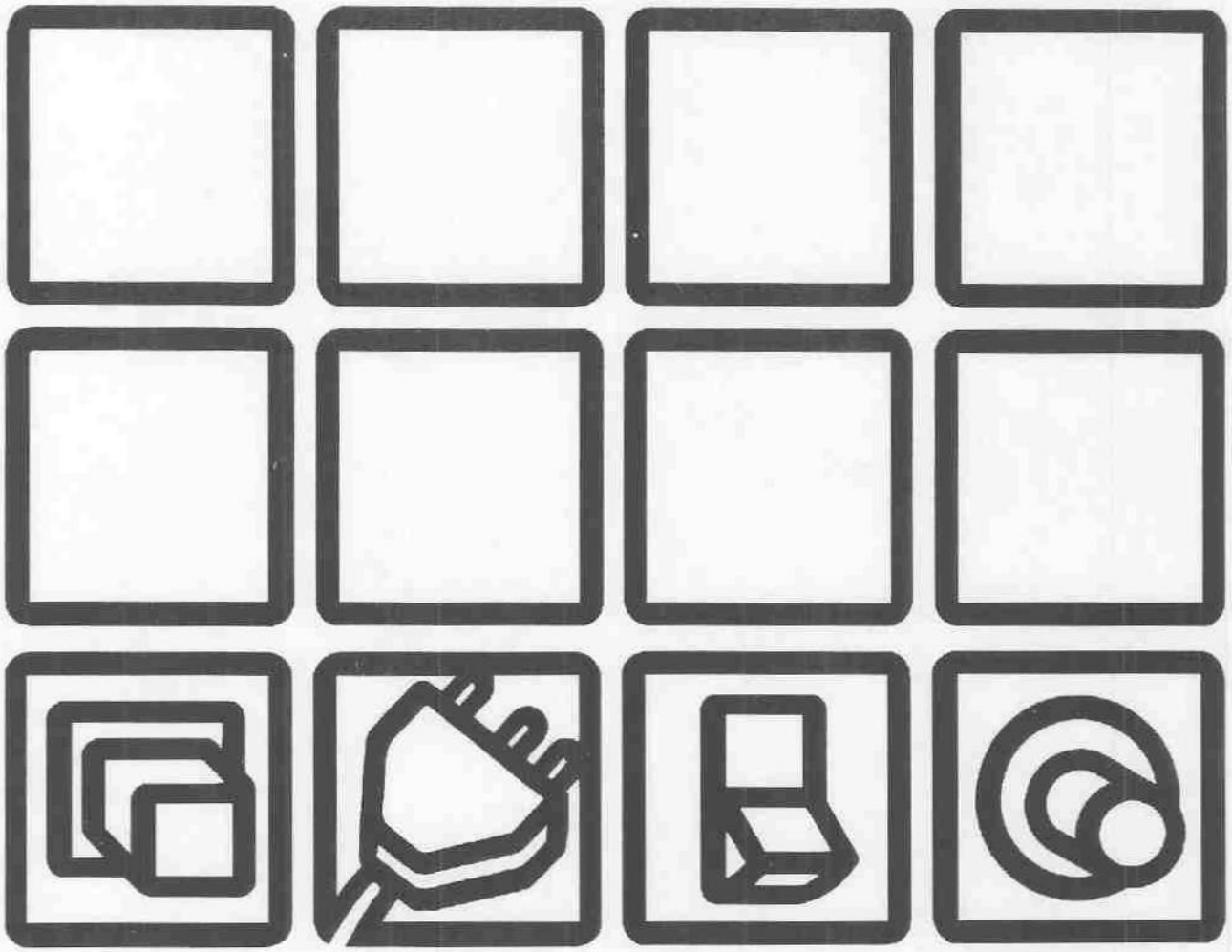

Valleylab

SSE2L

Service Manual

SSE2L®

Service Manual

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Effective Date: November 1991

Valleylab Part No.: 945 100 151

Equipment covered in this manual: SSE2L–20
Electrosurgical Generator
110 VAC Nominal

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INTRODUCTION

This Service Manual covers the installation and basic service instructions for the SSE2L Electrosurgical Generator. Also included are sections covering the Technical Specifications, Circuit Descriptions and the Testing of the generator. Instructions for use and cautions and warnings concerning electrosurgery are beyond the scope of this manual. The reader is directed to the SSE2L Instruction Manual supplied with the generator.

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CAUTIONS AND WARNINGS

WARNING: Risk of fire. Replace fuse as marked.

WARNING: Electric Shock Hazard: Always unplug the generator before cleaning.

WARNING: Electric Shock Hazard: Do NOT connect a wet power cord assembly to the generator or to the wall outlet.

WARNING: Electric Shock Hazard: Disconnect the power before replacing parts.

WARNING: Electric Shock Hazard: Do NOT touch any exposed wiring or conductive surface while the generator is disassembled and energized. Never wear a grounding strap when working on an energized generator.

CAUTION: This generator contains electrostatic sensitive components. When repairing the generator, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle the circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

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SECTION 1 — INSTALLATION

POWER FOR THE SSE2L

90 – 135 Vac, 50/60 Hz

The SSE2L is designed to operate over a wide range of input voltages within specified output regulation.

PROPER GROUNDING

To ensure patient safety the electrosurgical generator must be properly grounded.

The ground wire in the power cable is connected to the chassis and assures that no dangerous currents will flow from the cabinet of the generator in the event of an internal electrical failure. Do not use extension cords or three–prong to two–prong electrical adapters.

Undesirable 50/60 Hz leakage currents are also affected by the polarization of the 50/60 Hz input power. It is the responsibility of the user to ensure proper grounding and polarity of the power outlets supplying power to the SSE2L.

POWER PLUG

The SSE2L is shipped with an approved hospital grade three–prong connector. This connector meets all requirements for safe grounding. Its purpose should not be defeated by using extension cords or three–prong to two–prong adapters. The connector should be periodically inspected by qualified service personnel. Cords should always be grasped by the plug. DO NOT PULL ON THE CORD ITSELF.

ROUTINE MAINTENANCE AND INSPECTIONS

We recommend that the SSE2L be inspected by qualified service personnel twice a year. This Service Manual describes the recommended inspection, testing and calibration procedures. For major repairs the SSE2L can be returned to Valleylab. Repair parts or information needed to repair the generator may be obtained from Valleylab.

CLEANING INSTRUCTIONS

Clean the SSE2L using standard hospital procedures. Use a mild detergent and damp cloth to clean the generator cover, front panel and cord. Do not allow fluids to enter the generator. Do not use alcohol, caustic, corrosive, or abrasive cleaning materials. The generator cannot be sterilized.

SECTION 2 —
DESCRIPTION OF CONTROLS, INDICATORS AND RECEPTACLES

Figure 1 – Front View

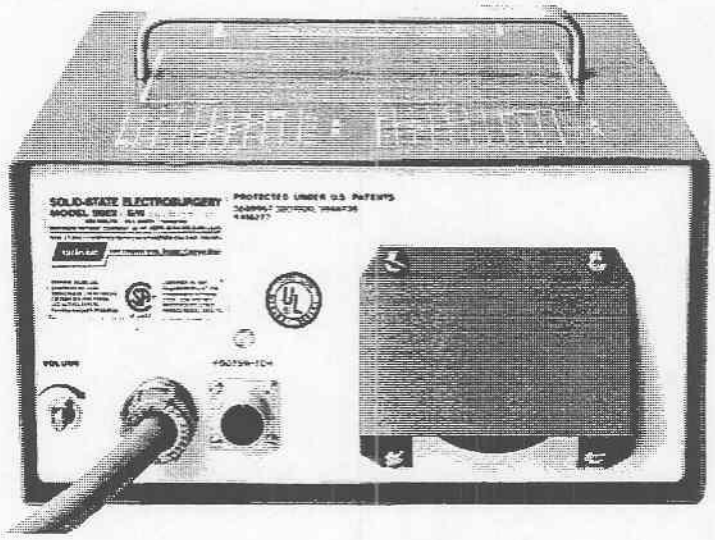
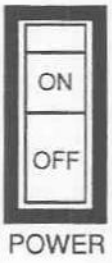


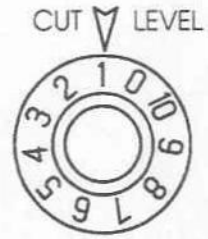
Figure 2 – Rear View

CONTROLS

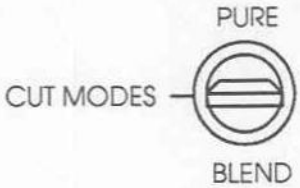


Power On Switch and Circuit Breaker – Rock the switch upward to turn the SSE2L on. The switch illuminates when the SSE2L is on. The power switch interrupts the current flow in case of internal failure or momentary overload. If the circuit breaker has tripped, press the switch to OFF then ON to reset it.

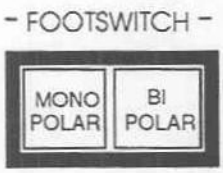
Coag Level Dial – The dial rotates clockwise to increase coagulation current intensity. The selector dial is graduated from 0 (no output) to 10 (maximum output). 220/240 volt models are graduated from 1 to 10.



Cut Level Dial – The dial rotates clockwise to increase Cut and Blend current intensity. The selector dial is graduated from 0 (no output) to 10 (maximum output). 220/240 volt models are graduated from 1 to 10.



Pure/Blend Selector – The two--position switch selects the type of cutting current, either PURE for minimum hemostasis while cutting, or BLEND for average hemostasis while cutting.



Footswitch Selector – These switches select whether the Monopolar accessory output or the Bipolar accessory output will be activated when the footswitch is depressed. Each switch illuminates to indicate which output has been selected.

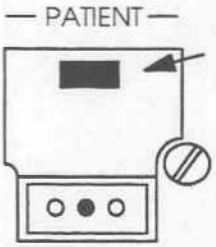
INDICATORS

Note: The CUT and COAG indicator lamps illuminate at the presence of usable radio frequency output in the respective mode. They will not illuminate at the minimum power setting.

Coag Mode Indicator – This indicator illuminates (blue) when coagulation current is selected by depressing the handswitching pencil COAG switch, depressing the footswitch COAG pedal, or by closing the forceps contact switch. A high frequency mode indicator tone will sound when the Coag mode is activated.

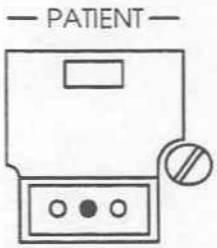
Cut Mode Indicator – This indicator illuminates (yellow) when cutting (pure or blended) current is selected by depressing the handswitching pencil CUT switch, or by depressing the footswitch CUT pedal. A low frequency mode indicator tone will sound when the Cut mode is activated.

ALERTS

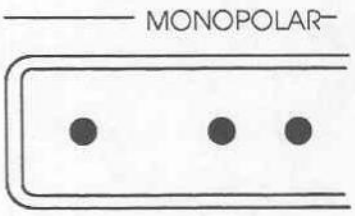


REM Fault Indicator – This indicator illuminates when the patient contact quality monitoring system senses that contact between the patient return electrode and the patient is not adequate. An intermittent alarm tone will sound. The generator will not produce output power when this alarm condition exists. The alarm condition is cleared when the REM system senses that the patient/pad contact resistance is within the acceptance range.

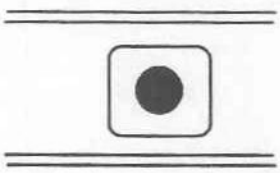
RECEPTACLES



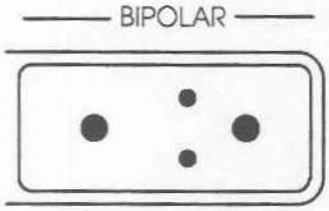
Patient Return Electrode Receptacle – This two–pin receptacle accepts the connector of the patient return electrode used in monopolar procedures. The receptacle will accept both REM (dual–section) and conventional patient return electrode connectors.



Monopolar (Handswitching) Receptacle – This output receptacle will accept three–pin handswitching active accessories or two–pin switching forceps. Power output from this receptacle is activated only by using the handswitch mechanism. The footswitch is inactive at this receptacle.



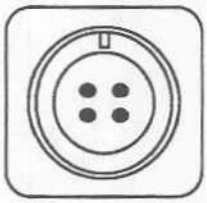
Monopolar Accessory (Footswitching) Receptacle – This output receptacle will accept most standard accessories of other manufacturers, or will accept 1/4" adapter plugs for those accessories that will not fit directly. The active accessory can only be activated by a footswitch when connected to this receptacle.



Bipolar Receptacle – This output receptacle will accept three–pin handswitching bipolar accessories. These accessories can also be footswitch–activated. This receptacle will also accept two–pin bipolar footswitching accessories.

REAR PANEL FUNCTIONS

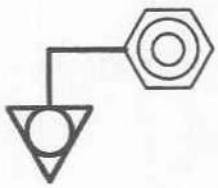
FOOTSWITCH



Footswitch Receptacle – This four–pin receptacle accepts a two–treadle monopolar footswitch connector.

VOLUME

Audio Volume Control – The volume of the Cut, Coag, and Bipolar mode indicator tones produced when the generator is activated may be adjusted with this control. The volume of the audio alarm tone is not adjustable.



Equipotential Lug – (220/240V only) This lug may be connected to earth ground with the furnished equipotential grounding cable.

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SECTION 3 —
TECHNICAL SPECIFICATIONS

In this Section, "typical" refers to a specification that is within 20% of a stated value.

OUTPUT WAVEFORM

Cut	500 kHz ± 10 kHz sinusoid with 65% 120 Hz modulation.
Blend	500 kHz ± 10 kHz sinusoid with increased amplitude bursts at 20 kHz.
Coag	Pulse modulated 450 kHz damped sinusoid. Burst duration 7.0 µSec, nominal. Burst repetition 20 kHz ± 2 kHz.
Bipolar	500 kHz ± 10 kHzsinusoid, unmodulated.

MONOPOLAR OUTPUT CHARACTERISTICS

Note: "CS" refers to Control Setting

Mode	Maximum (open circuit) P–P Voltage	Rated Load (Ohms)	Nominal Power CS = 10 (at Rated Load) (Watts)	Crest Factor @ Rated Load (typical)
Pure Cut	2800	500	375 ± 25	1.5 CS = 5
Blend	2440	500	250 ± 25	2.4 CS = 7
Coag	4070	500	125 ± 15	6.4 CS = 10

BIPOLAR OUTPUT CHARACTERISTICS

Mode	Maximum (open circuit) P–P Voltage	Rated Load (Ohms)	Nominal Power CS = 10 (at Rated Load) (Watts)	Crest Factor @ Rated Load (typical)
Pure Cut	700	100	90 +15 –20	1.8 CS = 5
Blend	640	100	85 +15 –20	2.1 CS = 5
Coag	1100	100	25 + 5 –10	5.1 CS = 5

OUTPUT POWER CONTROL

Cut, Blend and Coag output power is essentially linear with control rotation from settings of 1 to 10.

OUTPUT INTERACTION

The maximum power available from any nonactivated output must not exceed 20 watts for Monopolar outputs and 3 watts for the Bipolar output. Nonactivated power must be measured into a 500 ohm load for Monopolar outputs and a 100 ohm load for Bipolar output.

OUTPUT ISOLATION

Line frequency source leakage current: < 0.2 μA RMS
(Ground intact, normal and reverse polarity)

Line frequency sink leakage current*: < 150 μA RMS

RF patient leakage: < 150 mA RMS

Line ground leakage current (50/60 Hz)

- Unit off: < 10 μA RMS
- Unit on : < 30 μA RMS

* Line frequency sink current is that current which flows from an external voltage source of 120 VAC, 60 Hz applied to all front panel terminals in parallel, and 120k ohms in series with 120 VAC source.

INPUT POWER SOURCE

90 – 135 Vac, 50/60 Hz (Control Setting of 10, output short circuit)

Idle:	0.6 amperes
Cut:	12.0 amperes
Coag:	4.0 amperes

LINE REGULATION

Between 100 and 130 volts input, output power into a nominal load will vary no more than ± 20 watts in Cut/Blend mode, or ± 12 watts in Coag.

REM CONTACT QUALITY MONITOR

Output Waveform: sinusoid

Measurement Frequency: 140 kHz ± 20 kHz

Open Circuit Voltage: 1.25 V ± 10%

Short Circuit Current: 3 mA, max

Thresholds:

Single area pad mode: (alarm off) R = 5 ± 2 ohms
REM (dual–area) mode: nominal range 5 – 135 ohms

Hysterisis of thresholds (impedance difference between alarm and alarm silence):

Low impedance: 3 ohms ± 1 ohm
High impedance: 12 ohms ± 2 ohms

Threshold shift: With the generator activated at full output, Cut or Coag, into load or open circuit, thresholds will shift by 5 ohms or less.

AUDIO VOLUME

The audio mode indicator tones are adjustable to a maximum level of 65 dba at 1 meter. The alarm tone is not adjustable and is set at a maximum level.

COOLING

Single speed fan switches automatically. Airflow directed downward.

WEIGHT

32.5 pounds (14.7 kilograms)

SIZE

7.6 H x 11.6 W x 16.6 D inches (19.3 x 29.5 x 42.2 cm)

Specifications are subject to change without notice.

IMPORTANT: Per C.S.A. C22.2 #125, the degree of isolation of the SSE2L is suitable for Risk Class 2 application.

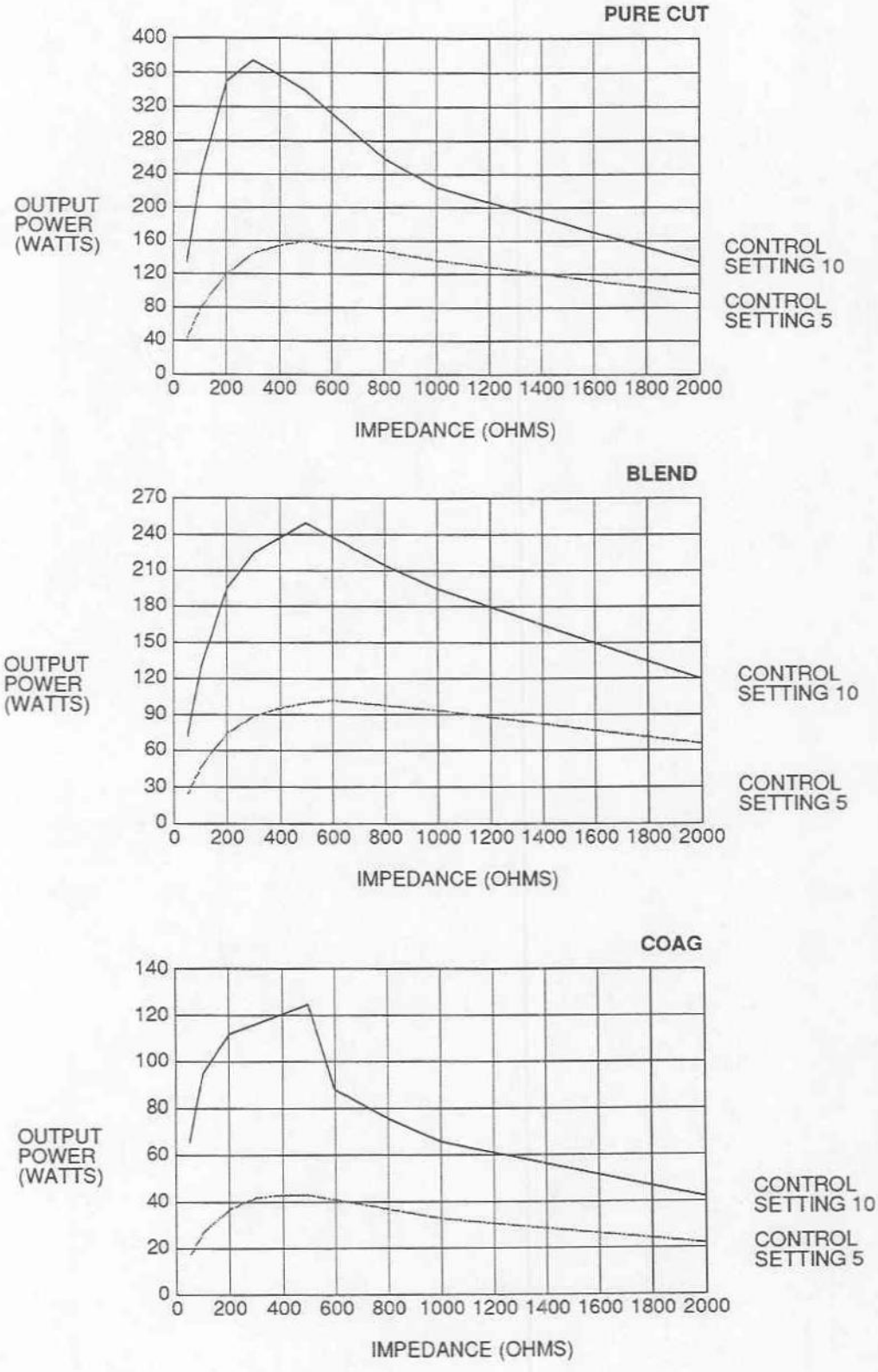


Figure 3 –
Typical Output Power vs Load – Monopolar

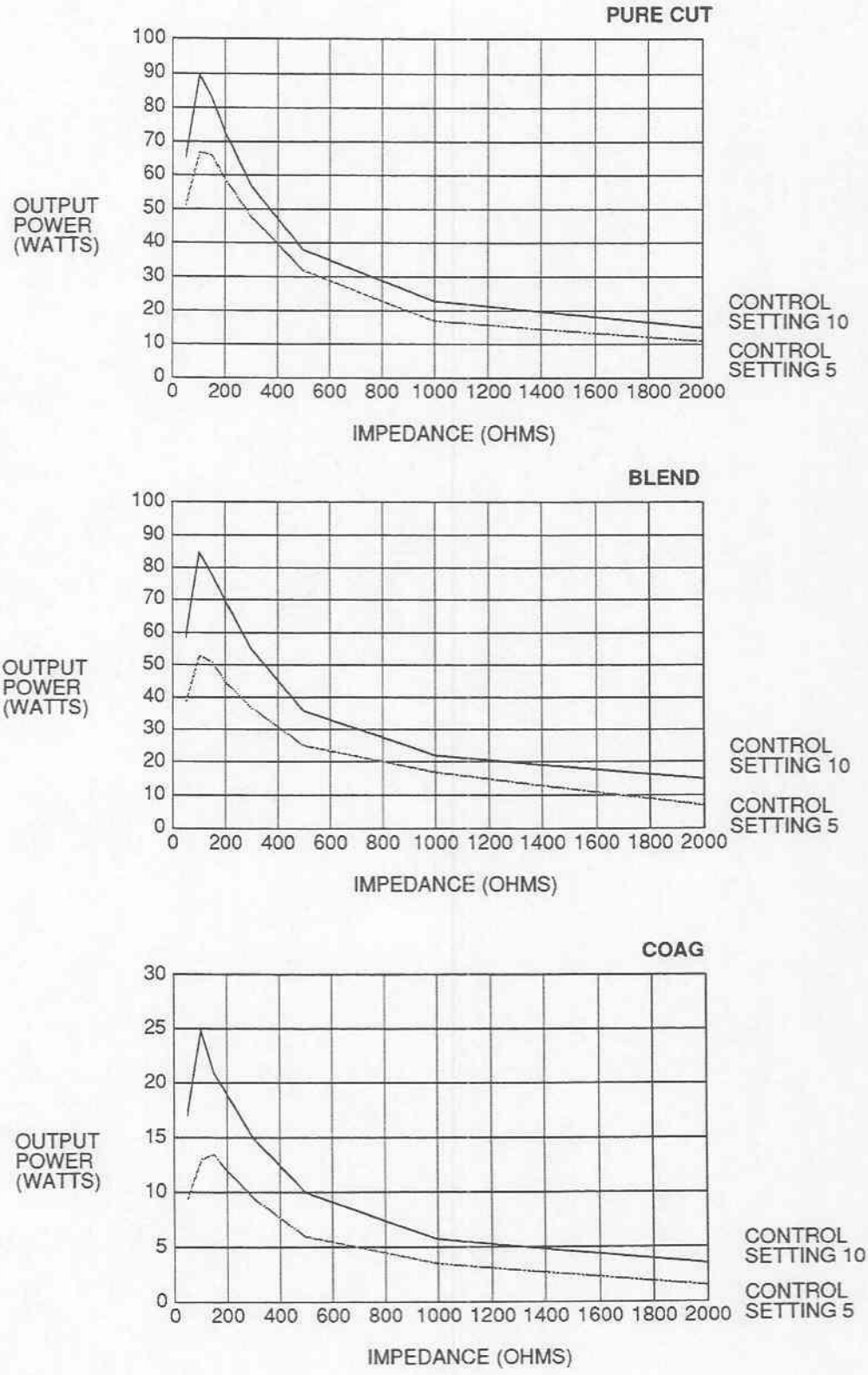


Figure 4 –
Typical Output Power vs Load – Bipolar

SECTION 4 —
CIRCUIT DESCRIPTIONS

The SSE2L consists of a power supply section, an RF oscillator, gating and shaping circuitry, a driver section, a power amplifier and three output circuits, only one of which will be energized at a time. Additionally there is logic circuitry to decode activating inputs, an IsoBloc circuit, an audio alert and a lamp driver circuit.

POWER SUPPLY (A2)

This section generates the necessary voltages for generator operation. The unregulated +220V output is capable of 1kW and is lightly filtered by C4. The unregulated +35V output is well filtered by C3, and from this the +20V and +15V regulated outputs are derived by U11 and U12, respectively. The power supply is protected by S1, which also serves as the on/off switch.

RF OSCILLATOR (A3)

Transistors Q1 and Q2 form a type of emitter coupled multivibrator whose free–running frequency is determined by C1, C2, C3 and associated resistors. In the Coag mode, C2 is switched into the circuit to lower the frequency and place the operating frequency closer to the resonant peak of (A4) T1 and (A5) T1. This enables the generator to develop higher peak voltages necessary for coagulating. In the Pure Cut and Blend mode the free–running frequency is 500 ± 10 kHz, and in Coag the frequency lowers to 450 ± 10 kHz.

GATING AND SHAPING CIRCUITRY (A3)

The signal from the collector of Q2 is inverted by Q3 and applied to phase splitter Q4. The collector load resistor of Q4 (R21) is connected to the +20 volt supply in one of three ways to furnish the different waveforms. In the Pure Cut mode, the top of R21 is connected to +20V through contacts of the PURE/BLEND switch and K1 pins 9 and 10 and allows a CW signal to pass on through Q6 and Q8 and be amplified by the Driver and Output stages. In the Blend mode the top of R21 is returned to an intermediate voltage through the contacts of K1–9 and 10 and the PURE/BLEND switch. This allows reduced level of CW signal to pass on to Q6 and Q8. At the same time, the Coag oscillator U1 causes the top of R21 to be periodically pulled to the full +20V supply through Q7. This action adds higher amplitude pulses to the already generated CW signal and results in a Blend waveform.

In the Coag mode, the contacts of K1 do not activate. Instead, the top of R21 is pulled up to the +20V supply by U1 and Q7 at the Coag rep–rate (20 kHz). The RF oscillator consisting of Q1 and Q2 runs only when the generator is activated ON due to the action of Q10. Coag oscillator U1 runs continuously. When either mode is activated, Q5 is disabled and allows the Coag rep–rate signal to be applied to Q7. In the Pure Cut mode, the Coag signal is also applied to Q7 but has no effect because Q7 is bypassed by the contact of K1–9 and 10 and the PURE/BLEND switch. The inverted signal from the emitter of Q4 is applied to the base of Q9 and is used to remove the stored base–charge in A7Q1 and allow it to switch faster with less power dissipation.

DRIVER CIRCUIT (A4, A7)

One output of the shaping circuitry is passed through the level controls to the base of (A7) Q1. A turn–off drive is passed directly to (A7) Q1 to handle the large amounts of stored charge present in this type of transistor during conduction. A second input to this stage is through (A4) R8 and (A4) R16. This path creates a voltage on the emitter of (A7) Q1 which is proportional to the unregulated +35V supply, and

thus to the power line voltage. It is in this way that the SSE2L is compensated for power line voltage fluctuations. The driver stage is a tuned amplifier which is transformer–coupled and matched to the loading of the output stage.

POWER AMPLIFIER (A7)

This stage increases the power level of the signals to the level required for surgery. It is a tuned amplifier which is transformer–coupled for load impedance matching. Q2 through Q8 are connected in parallel (with individual emitter resistors for even current sharing). A feedback path is included through R4 and C1 for stability. The power amplifier is driven at one of two frequencies. (See RF Oscillator.) At the lower frequency there is a correspondence between drive and resonance, and the highest open circuit voltages are developed for adequate coagulation performance. Conversely, during pure cutting operation, the stage is driven slightly off resonance to limit the open circuit voltage.

OUTPUT SECTION (A5)

The SSE2L features three individually activated output circuits for operation: Monopolar Handswitching mode, Monopolar Accessory mode, and Bipolar mode. A typical output circuit consists of a transformer, DC blocking capacitors in the secondary, and in the Monopolar circuit, a leakage canceling circuit from the active secondary to ground. The primaries of the three transformers are commoned together at one end and are connected to the collector terminal of the output transistor array. The +220V power supply is commutated by K1 and K2 to one of the open primary leads depending on which output is selected.

activated LOGIC (A2)

The activating logic accepts inputs from the footswitch directly on FSCT and FSCG and from the handswitch inputs via the IsoBloc circuit on HSCT, HSCG, BPCT and BPCG. BPS is set by the FOOTSWITCH selector on the front panel of the generator. U1, U2, U3, and U4 form a mutually exclusive gating array which allows only one logic input to be activated at a time. Outputs Q1 and Q2 energize Cut and Coag relays (A1) K1 and (A1) K2, respectively. Outputs Q3 and Q4 energize power relays (A5) K1 and (A5) K2. Delays created by R13 C8, R14 C9, R15 C10, R16 C11, and R17 C12 assure that (A5) K1 and (A5) K2 "cold switch" to prevent contact burning.

ISOBLOC CIRCUIT (A6)

The IsoBloc circuit permits activating the generator with handswitching accessories while maintaining a high degree of RF isolation. Q1 is a 100 kHz oscillator which supplies current to the light emitting diodes in the photoisolators PI1, PI2, PI3, and PI4. CR1 C5 and CR2 C6 rectify and filter the energy transferred through T1. When the anode of the LED portion of one of the photoisolators is connected to the appropriate active lead, the diode emits light and current flows in the corresponding phototransistor.

LAMP ENABLE CIRCUIT (A6)

When RF is present at the primary of output transformer T1, current flows through C11 causing Q2 to turn on supplying current to the appropriate indicator lamp. In this way, the lamps are directly indicative of available output power. The lamps will not light at the zero setting.

AUDIO CIRCUIT (A2)

U9 is a quad 2 input NAND logic gate which is connected as an astable oscillator to generate two different tones for audible indication of the selected mode. The output of the oscillator drives the speaker amplifier Q5. (A1) R3 allows control of the speaker volume.

LEAKAGE CANCELING CIRCUITS (A5)

Active–to–ground capacitance causes undesirable RF patient leakage current. L1 and L2 form a pole of impedance with typical active stray capacitance so that the net leakage producing effect of the active–to–ground capacitance is reduced. The ground connection of the inductance is isolated by a capacitor so that the low frequency sink capability is limited. R1 and R2 provide adequate damping in this circuit for the Coag mode.

REM CONTACT QUALITY MONITOR CIRCUIT (A8)

A two–wire patient return electrode is connected between E1 and E2, an RF source to E3 and a speaker to J103–1 and J103–2. J101–1 is used to inhibit generator operation in the event of a detected error. Oscillator (U4) drives a transformer network (T2) and a synchronous detector (U6) so that a differential voltage between C12 and C13 is representative of the resistance between E1 and E2. A very high degree of normal mode noise rejection is required. Flip–flop U7 is used to provide a symmetrical square wave, and U5 provides fast edges for accurate multiplexer operation. C18–C20 isolates the transformer from all DC drive voltages so that, in the event of transformer failure no hazardous potentials will be presented to the patient. A double–ended output is presented so that the detector will be loaded symmetrically. However, only one of the outputs is used by the comparator circuit. The single–ended output voltage is approximately 0 to +300 mV with respect to the +6V supply for a 0 to 135 ohm range. Two comparators contained in U4 and U2 are set to give high and low limits on patient return electrode resistance. Hysterisis is provided on each comparator to ensure stable switching.

Exclusive OR gate U3A is activated by a switch in the face assembly. If the switch is not activated by a plug pin, the low resistance value is used for an upper limit. This mode is used for conventional electrodes. The dual–area REM patient return electrode has a pin on its plug which activates the switch and the low resistance value becomes the lower limit. In either case, when the resistance is within its acceptable range, Q1 is on and RF output is not inhibited. U5C and U5D along with U1 and T1 form an audio oscillator where output impedance is high when inhibited by a logic 1 on U1 pin 2 and low with logic zero. This allows direct connection across the speaker and audio driver. When U1 pin 5 output is high, C11 is being charged and when U1 switches state, the charge on C11 is discharged through pin 4, U1. This discharge current lights an LED mounted in the PATIENT receptacle housing.

SECTION 5 —
TESTING AND CALIBRATION PROCEDURES

OPERATIONAL TESTING – GENERATOR OUTPUT

The purpose of an operational test is to determine whether the generator is functioning and is generating the necessary electrosurgical waveforms. In the Acceptance Testing and Calibration Procedure, measurements are described which accurately determine the condition of the generator.

Note: The SSE2L is not rated for continuous duty operation.

When the generator is turned on, the ON lamp should illuminate with normal brilliance. A dim glow of the ON lamp may indicate a heavy current drain from the +220 and the +35 volt supplies. This condition generally indicates faulty power supply components.

The REM circuit must be functioning and in the correct mode to get RF power output. To test REM, turn the generator power ON without a patient return electrode connected. The REM alarm should sound, the red LED should flash, and power output should be inhibited. There are two modes of REM operation, the single–pad mode and the dual–pad mode. To test these modes, connect the appropriate patient return electrode and test the resistance parameters.

When a single–pad patient return electrode is connected, the two pins of the connector are shorted together, offering a resistance range of 0 to 5 ohms. The REM alert should cease and power output will be available when the generator is activated.

When a REM Patient Return Electrode is connected, proper operation will be achieved only when the resistance between the two pads of the patient return electrode fall in the range of 5 to 135 ohms. Any other resistance will cause a REM alarm and output power to be inhibited.

Radio Frequency Leakage Current

RF leakage to earth ground is detrimental in the use of isolated electrosurgery. The leakage is minimized in the SSE2L to less than 150 mA RMS. When the SSE2L is activated with a footswitch, this leakage can be seen as a small spark between the active electrode or patient return electrode cord and the chassis. This spark can best be evaluated by comparison with a test generator known to be working properly.

The RF Leakage Test Procedure outlines the method used to accurately measure this leakage current. Because of the high crest factors in the waveforms involved, the use of a thermocouple–type RF Ammeter is imperative to prevent errors in this measurement.

Excessive RF leakage from the PATIENT terminal has the effect of raising the patient to an RF potential with respect to ground. These voltages can cause operating room personnel to be "shocked" when lightly touching the patient. These shocks are tiny pinpoint RF burns and although not dangerous to the patient or operating room personnel, are disagreeable and should be avoided.

Excessive RF leakage from an "active" receptacle has the effect of allowing surgery to be performed without benefit of a patient return electrode and is an undesirable situation. For this reason, RF leakage measurements should be performed periodically to ensure patient safety.

Cross Coupling Test

The effects of capacitive and inductive coupling at the high frequencies involved will cause some unwanted RF output to be present at the nonactivated outputs when the generator is activated. The purpose of this test is to ensure that this stray RF is within acceptable limits.

Power levels must be measured using a 500 ohm load for the MONOPOLAR outputs and a 100 ohm load for the BIPOLAR output.

Nonactivated power is measured at each of the three outputs with the appropriate load while activating each of the remaining two outputs at maximum output in Cut and Coag modes and into both open and shorted loads. Power measured at the nonactivated receptacles must not exceed 20 watts or the MONOPOLAR output and 3 watts for the BIPOLAR output.

50/60 Hz Current Leakage

There is no simple means of taking these measurements. Sensitive instruments are needed to measure the low values of current involved. The 50/60 Hz leakage is measured with the SSE2L ON, but NOT activated.

The measuring procedure is described in detail in the Line Frequency Leakage Current Test. Due to the potential danger to an electrically–susceptible patient in the case of excess 50/60 Hz leakage, generators suspected of this fault should be carefully tested and inspected.

ACCEPTANCE TEST AND CALIBRATION PROCEDURES

Equipment Needed:

- Tektronix type 465 Oscilloscope
- Tektronix type P6013A HV Probe
- Tektronix type P6007 X100 Probe
- Tektronix type P6010 X10 Probe
- Simpson Model 1339 RMS Ammeter 0–250 mA
- Wattmeter, 0–500 W, 500 ohm load
- Wattmeter, 0–100 W, 100 ohm load
- General Radio Co. 0–140 Vac Variac (Variable Voltage Transformer)
- REM Patient Return Electrode (connector with pin)
- Decade Resistance Box, (or a multi–turn >150 ohm potentiometer)
- Line Frequency Leakage Network
- Digital Multimeter
- 40pf, 5000V Capacitor

In testing RF type equipment, proper test procedures must be adhered to in order to duplicate factory obtained data. Test leads must be kept to the minimum length usable; lead inductance and stray capacitance can adversely affect readings. The selection of suitable "ground" points must be made with care to avoid ground loop errors.

Keep in mind that meter accuracy of many RF instruments is 5–10% of full scale. Using uncompensated oscilloscope probes may cause large errors in the measurement of high voltage RF waveforms. When fractional microampere leakage currents are measured, accidental capacitive or inductance coupling may cause order–of–magnitude errors in the observed values.

The SSE2L features individually activated outputs. These test procedures are written under the assumption that the Monopolar Handswitch output will be used. However, the Monopolar Accessory output may be used by activating the generator with the footswitch.

Chassis Ground Integrity

Check for the existence of a low impedance connection between the generator chassis and the third–wire ground plug. To avoid any problems of contact resistance in measuring this impedance (0.1 ohm), it is recommended that four–wire resistance measuring technique be used. The recommended maximum impedance of 0.1 ohm is for the standard factory installed 15 foot, 16/3 AWG line cord. Use of longer cords is not recommended.

Initial Functional Test

Power the generator from a variable voltage transformer capable of furnishing at least 12.5 amperes at 120 Vac. Turn the generator ON and activate the Cut mode. Ensure that the generator starts to function at 90 Vac or lower. The presence of the mode indicator tone and illumination of the CUT and COAG lamps is indicative of proper operation for this test.

The CUT and COAG lamps are enabled by a circuit which detects an RF output. Therefore, the level controls must be set at about (1) before the light will appear.

OUTPUT POWER LEVELS

Monopolar output power levels are specified for the Monopolar Handswitch output of the SSE2L. Component variations between the Monopolar Accessory and the Monopolar Handswitch output circuits may cause the relationship between control setting and output power to differ slightly between the two. Adjustment of output power levels must be done while in the Monopolar Accessory mode. It is then necessary to repeat the measurement procedure while in the Monopolar Handswitch mode to verify that corresponding output power levels track within 10%. The measurement procedure must be performed a third time in Bipolar mode to ensure that Bipolar output levels are within specification.

When measuring output power levels it is important to maintain a line voltage of 120 Vac. If a variable voltage transformer is not available for this purpose and the generator must be tested at the existing voltage, the output power will differ from that at 120 Vac input. Output powers will be proportionately higher or lower depending on the line voltage available. Within the range of power from 0 to 200 watts in Pure and Blend, 0 to 75 watts in Coag, and input voltages from 100 to 130 Vac, the output is regulated and varies less than $\pm$ 20 watts in Cut and $\pm$ 12 watts in Coag.

Pure Cut Levels

In this procedure the generator is operated into a 500 ohm wattmeter capable of dissipating the full power of the generator (400W).

a. Connect a wattmeter between the PATIENT receptacle and the Monopolar Accessory receptacle. The generator is activated by the footswitch. The PATIENT receptacle may be connected to chassis ground to ensure proper operation of an oscilloscope.

b. Set the Cut level to (10) and place the PURE/BLEND switch in the PURE position and activate the generator. Power output should be 375 $\pm$ 25 watts.

c. Set the CUT level to (7) and verify that the power is 245 $\pm$ 30 watts.

d. Set the CUT level to (5) and verify that the power is 160 $\pm$ 30 watts.

e. Set the CUT level to (2) and verify that the power is 35 $\pm$ 20 watts.

f. Set the Cut level to (10). Remove the 500 ohm load and check the open circuit output voltage with the 1000X oscilloscope probe. This should not exceed 2800 volts peak–to–peak.

If the generator power output does not meet the preceding requirements it will be necessary to calibrate to the proper levels as follows:

a. Connect a frequency counter to the collector of (A3) Q3 on the Multiboard and select the value for (A3) C3 which will give a carrier frequency of 500 ± 10 kHz when activated in the Cut mode. Set the Coag level to (1) and activate the generator in Coag. Note that the frequency is 450 ± 10 kHz.

b. Set the Cut level to (10) and connect the 500 ohm wattmeter as described above. Activate the generator in Pure Cut and select value for (A3) R30 which gives 375 ± 25 watts of RF output power.

c. Check power at Cut level settings of (7) and (5) to see that they are within the limits set above. Power at midrange settings may be adjusted by changing the value of (A3) R32. See Section 3 for typical output curves. Check power at Cut level setting of (2). Output should be 35W ± 20. This can be adjusted by changing the value of (A1) R7.

Blend Levels

a. Connect the 500 ohm wattmeter as before and set Cut level to (10).

b. Place the PURE/BLEND switch in BLEND position and activate the generator. Power output should be 250 ± 25 watts.

c. Set the Cut level to (7) and verify that the power is 140 ± 20 watts.

d. Set the Cut level to (5) and verify that the power is 95 ± 20 watts.

e. Set the Cut level to (2) and verify that the power is 25 ± 15 watts.

f. Midrange power levels may be adjusted by changing the value of (A1) R2.

g. With the wattmeter still connected, set the Cut level to (5) and activate the generator. Observe the output waveform with the oscilloscope and ensure that the ratio of peak Coag to peak Cut voltage is between 1.6:1 and 2.0:1. If the ratio is higher than 2.0:1, it may not be possible to meet the specified power requirements. The ratio is set by (A3) R25.

Crest factor may be calculated from the formula CF = Epk/Erms or Ipk/Irms. The peak voltages or current may be measured with an oscilloscope and the RMS values with an RMS voltmeter or ammeter.

Coag Levels

a. Connect the 500 ohm wattmeter as before.

b. Set Coag level to (10) and activate the generator in Coag. Power output should be 125 ± 15 watts.

c. Set the Coag level to (7) and verify that the power is 75 ± 10 watts.

d. Set the Coag level to (5) and verify that the power is 45 ± 10 watts.

e. Set the Coag level to (2) and verify that the power is 10 ± 5 watts.

f. Midrange power levels (in Coag mode) may be adjusted by changing the value of (A1) R9.

g. Check that the Pulse Repetition Rate is 20 ± 2 kHz (50 ± 5 µS) and that the burst width is 7 ± 3 µS. (A3) R14 and (A3) R15 may be changed in value to vary the PRR and burst width within the limits stated. Varying these parameters will allow control over maximum output power in Coag.

h. Set the Coag level to (10). Remove the 500 ohm load and check the open circuit output voltage. This should be greater than 3500 volts peak–to–peak.

MONOPOLAR HANDSWITCH TEST

a. Connect a monopolar handswitching accessory to the Monopolar Handswitch output of the generator.

b. Connect a 500 ohm wattmeter between the PATIENT receptacle and the electrode of the handswitching accessory. The generator operates in a manner similar to that outlined previously and output levels are measured and verified to be within 10% of those measured at the Monopolar Accessory output.

BIPOLAR TEST

For this test the generator is again activated with a footswitch but with a 100 ohm wattmeter connected between BIPOLAR OUTPUT 1 and BIPOLAR OUTPUT 2.

a. Place the PURE/BLEND switch in the PURE position, and set the Cut level at (10).

b. Place the FOOTSWITCH selector in the BIPOLAR position and activate the generator in the Cut mode. Power output should be 90 W +15, –20.

b. Set the Cut level to (7) and verify that the power is 85 W +15, –20.

c. Set the Cut level to (5) and verify that the power is 75 W +15, –20.

d. Set the Cut level to (2) and verify that the power is 25 W +10, –15.

e. Set the Cut level to (10), remove the 100 ohm load and check the open circuit voltage. This should be typically 625 volts peak–to–peak.

f. Reconnect the 100 ohm wattmeter and place the PURE/BLEND switch in the BLEND position.

g. Set the Cut level to (10) and activate the generator. Power output should be 85 W +15, –20.

h. Set the Cut level to (7) and verify that the power is 70 W +15, –20.

i. Set the Cut level to (5) and verify that the power is 55 W $\pm$ 15.

j. Set the Cut level to (2) and verify that the power is 15 W +10, –15.

k. Set the Coag level to (10) and activate the generator. The output power should be 25 W +5, –10.

l. Set the Coag level to (7) and verify that the power is 20 W +5, –10.

m. Set the Coag level to (5) and verify that the power is 15 W $\pm$ 5.

n. Set the Coag level to (2) and verify that the power is 5 W $\pm$ 3.

o. Set the Coag level to (10), remove the 100 ohm load and check the open circuit voltage. This should be typically 1100 volts peak–to–peak.

REM CONTACT QUALITY MONITOR

In the event REM did not function as described in the Operational Testing section, a REM alignment should be conducted as follows:

Remove the brass shield box from the REM Module. The REM PCB Assembly may be placed on top of the power transformer with the insulating bracket underneath.

Oscillator Alignment

a. Connect the DMM to TP1 (+) and TP2 (–), set it to 2.0 VDC full scale.

b. With no connection to the PATIENT receptacle, adjust L1 (oscillator inductor) for a maximum reading on DMM. NOTE: C7 is a .0033 µf polycarbonate dielectric capacitor which may be installed to set the range of adjustment on L1. If the capacitor is not in place and the peak voltage is not reached when L1 adjuster is fully clockwise, install C7 (using only the Valleylab part) and readjust L1. Conversely, if a peak reading is not obtained with L1 adjusted fully counterclockwise, remove C7 and readjust L1.

Threshold Adjustment

a. Set the decade resistor to 135 ohms.

b. Rotate R20 counterclockwise until the alert flashes and sounds. Rotate R20 clockwise to silence alert, then slowly counterclockwise until alert flashes and alarm sounds. This adjustment must be precise.

c. Decrease the resistance and record the value at which the REM alarm again turns on (5 ± 2 ohms).

d. Repeat the above test setup utilizing a non REM–type connector.

Volume Adjustment

a. Adjust R16 for 2.0V peak–to–peak at the speaker using an oscilloscope.

Reinstall the REM board and shield can. Replace the generator cover and verify that the REM system meets the specifications.

RF LEAKAGE TEST

RF leakage currents from receptacle to ground are measured with 40 pf connected from the "hot" active receptacle to ground. This simulates the stray capacitance of a ten foot active accessory cord found in actual operating conditions. This capacitance resonates with the inductance of leakage canceling circuit to minimize RF leakage at the PATIENT receptacle.

Note: Short leads are recommended for the RF leakage test.

a. Connect the 250mA RF ammeter from the PATIENT receptacle to ground.

b. Set the Cut and Coag level controls to (10) and activate the generator alternately from the Monopolar Handswitch receptacles and from the footswitch in both Cut and Coag modes. Verify that the RF leakage current does not exceed 150 mA RMS.

c. Connect the 250 mA RF ammeter alternately from the Monopolar Handswitch and the Monopolar Accessory receptacles to ground, and while activating the corresponding output in both Cut and Coag modes, verify that the RF leakage does not exceed 150 mA RMS.

d. Connect the 250 mA RF ammeter alternately from the Bipolar Output 1 and the Bipolar Output 2 to ground, and while activating the generator in Cut and Coag modes, verify that the RF leakage does not exceed 150 mA RMS.

LINE REGULATION TEST

a. Connect the SSE2L to a variable voltage transformer and set the supply voltage to 115 Vac.

b. Select Pure or Blend mode and set the generator output to 200 watts into a 500 ohm load, while keeping the supply voltage constant. Vary the supply voltage from 100 Vac to 130 Vac. The output should vary less than ± 20 watts.

c. Return the supply voltage to 115 Vac and set Coag power to 75 watts. Vary the supply voltage from 100 Vac to 130 Vac. Output power should vary less than ± 12 watts.

POWER SAG TEST

a. Connect the SSE2L to a variable voltage transformer and set the supply voltage to 120 Vac.

b. Select the Blend mode and set the Cut level to (7). activate the generator into a 500 ohm load wattmeter and note the power. Continue activating the generator for 60 seconds and again note the power. The final power after activating for 60 seconds should be at least 80% of the initial power.

c. Select the Coag mode at a level of (7) and activate the generator as described above, noting the final and initial power. The final power after 60 seconds should be at least 80% of the initial power.

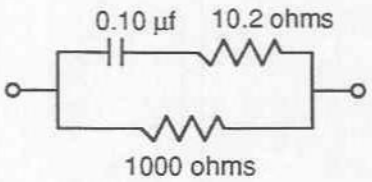
COOLING FAN TEST

The cooling fan has one speed and will switch on when the cooler assembly reaches 160°F ± 10°F. The fan switches off at 140°F ± 10°F. To test the fan operation, set the Cut level to (10) and activate the generator with no load. The fan should switch on within 240 seconds (4 minutes). If it does not, check the thermal switch assembly before proceeding.

LINE FREQUENCY LEAKAGE CURRENT (50/60 Hz) TEST

Potentially dangerous 50/60 Hz line leakage currents to ground are measured in this test. The SSE2L is left ON, but NOT activated. The current is measured indirectly by observing the voltage developed across from a 1k ohm resistor to ground from each output receptacle. A 0.10 µf capacitor is connected across the 1k resistor to ground to remove any trace of high frequency noise generated by the multivibrator inside the generator. It has little effect on the actual 50/60 Hz leakage current. Leakage current is calculated from I = E/R where R = 1,000 ohms and E is the voltage across the resistor. The maximum acceptable voltage across the 1k resistor for 0.2 µA leakage is .0002V (0.2 millivolts).

INPUT CIRCUIT:



NOTE: Because of the extreme difference in magnitude of the 50/60 Hz leakage current and the 500 kHz signal (when activated), it is very difficult to make a 50/60 Hz leakage measurement with the generator activated. When activated, there can be as much as 4000 volts peak–to–peak of 500 kHz, as compared to 0.2 millivolts of 50/60 Hz. This ratio (20,000,000:1) of voltages would necessitate the use of sophisticated measuring techniques. In actual use, the 50/60 Hz leakage currents do not change significantly from the active to the inactive mode.

Third Wire Leakage

Third wire leakage current is measured by opening the green/yellow grounding wire at the power plug and connecting the 1k resistor from chassis to ground. The maximum voltage for 30 μA leakage would be 0.03V (30 millivolts). Commercially available leakage testers may be used for this test.

The typical value of 30 μA is valid for factory installed 15 foot 16/3 AWG line cords. Longer power cords or extension cords increase the third wire leakage and are not recommended. With the SSE2L turned OFF, the third wire leakage should be less than 10 μA.

The line frequency sink leakage is the current that passes into the patient leads when a 120 volt 50/60 Hz potential is applied between a patient lead and the chassis.

The voltage source should be a 120 volt isolation transformer with a 120k ohm current limiting resistor in the secondary. The current is calculated from the voltage measured across a 1k ohm resistor in series with the 120 volt source and the PATIENT or "active" receptacles. This current should be less than 150 μA.

PREVENTIVE MAINTENANCE

In order to ensure safe and dependable operation, the SSE2L should be periodically checked to see that it meets minimum specifications.

Depending upon conditions in the hospital environment, it may be necessary to occasionally clean the interior of the generator using dry, pressurized air. Lint and dirt should not be allowed to build up on the high voltage terminals or on the cooling fan. The printed circuit boards should be examined for any signs of corrosion on the contact fingers and should be cleaned as necessary.

Any lowering of the generator's full output power may indicate one or more power transistors and/or fuses are inoperable. Because of the redundant circuitry, the generator may continue to function almost normally with one or more power transistors inoperable.

It is recommended that the SSE2L be inspected at least twice a year and the Acceptance Testing and Calibration Procedures be performed at that time to ensure efficacy and continued patient safety.

NOTE: To change ON/OFF lamp, turn the switch OFF. Use pliers to pull the rocker straight out. The lamp is held in by spring clips. Carefully replace the bulb and replace rocker by snapping into place.

SECTION 6 — TROUBLESHOOTING

TROUBLE/SYMPTOM

Inoperative ON/OFF; switch won't stay on.

PROBABLE CAUSE	SOLUTION
1. Faulty power line wiring	1. Correct the wiring fault.
2. Excess current drain	2. Check for shorted A9 CR1. Check for +200 Vdc shorted to ground.
3. Nonfunctional circuit breaker	3. Replace nonfunctional A9 S1.

TROUBLE/ SYMPTOM

ON/OFF lamp does not illuminate.

PROBABLE CAUSE	SOLUTION
1. Bulb burned out	1. Remove plastic rocker and replace bulb.
2. A1 R4 burned out	2. Replace A1 R4, 390 ohm 3.25 watt resistor.

TROUBLE/SYMPTOM

Will not activate at handswitch from MONOPOLAR receptacle. Activates OK with footswitch.

PROBABLE CAUSE	SOLUTION
1. IsoBloc oscillator not running	1. Check A6 Q1 and A6 T1.

TROUBLE/SYMPTOM

One handswitch input inoperative.

PROBABLE CAUSE	SOLUTION
1. IsoBloc Board	1. Check A6 P1, A6 P2, A6 P3, and A6 P4.

TROUBLE/SYMPTOM

No CUT. COAG OK.

PROBABLE CAUSE	SOLUTION
1. Relay	1. Check relays A1 K1 and A1 K2.

TROUBLE/SYMPTOM

No COAG. CUT OK.

PROBABLE CAUSE	SOLUTION
1. Relay	1. Check relays A1 K1 and A1 K2.
2. Multiboard	2. Check A3 U1, A3 Q5 and A3 Q7.

TROUBLE/SYMPTOM

No BLEND; CUT and COAG OK.

PROBABLE CAUSE	SOLUTION
1. PURE/BLEND switch	1. Check A9 S2

TROUBLE/SYMPTOM

Low Power

PROBABLE CAUSE	SOLUTION
1. Cooler Assembly	1. Check A7 Q2–Q8 for shorts. Fuses A7 F1–F14 opened.

TROUBLE/SYMPTOM

No output in any mode. Relays OK.

PROBABLE CAUSE	SOLUTION
1. Multiboard	1. Check output at J2–J. Check signal at A3 Q1–Q3. Check +20V supply at J2–P.
2. Driver circuit	2. Check A7 Q1, A4 F1 and A4 R7.

TROUBLE/SYMPTOM

No audio mode indicator tone when activated.

PROBABLE CAUSE	SOLUTION
1. Audio oscillator	1. Check A2 U9, A2 Q5 and A2 LS1.

TROUBLE/SYMPTOM

No MONOPOLAR output; BIPOLAR OK.

PROBABLE CAUSE	SOLUTION
1. Output Board	1. Check A5 K1 and A5 K2.

TROUBLE/SYMPTOM

No BIPOLAR output; MONOPOLAR OK.

PROBABLE CAUSE	SOLUTION
1. Output Board	1. Check A5 K1 and A5 K2.

TROUBLE/SYMPTOM

Excess RF leakage current.

PROBABLE CAUSE	SOLUTION
1. Output Board	1. Check A5 C1, C2, L1, L2, R1 and R2 for shorts.
2. IsoBloc Board	2. Check A6 T1 for short.
3. Wiring short	3. Active or patient wire shorted to chassis.

TROUBLE/SYMPTOM

Excess 50/60 Hz leakage.

PROBABLE CAUSE	SOLUTION
1. Nonfunctional power transformer	1. Replace A1 T1.
2. Wiring fault	2. Check for broken ground wire or hot and neutral wires reversed.

TROUBLE/SYMPTOM

No RF output.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Connect inhibit signal to ground. (J1–1). If the generator still won't produce and output, the REM is not at fault. If generator does produce an output, then check Q1, U3. J1 connections, VR1, U2 (+12V, +6V).

TROUBLE/SYMPTOM

No REM audio or visual alarm, but power output is inhibited.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check J1 connections VR1 U2 (+12V, +6V), U5, R16, U1. T1 check R34, C26 for visual alarm.

TROUBLE/SYMPTOM

Generator doesn't inhibit on open circuit, when improper impedance is across patient return electrode connector.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check U4, T2, L1 (tuning), U6, voltage at TP1–TP2.

TROUBLE/SYMPTOM

High Z trip level is incorrect.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check R20, U4, T2, L1 (tuning), U6, voltage at TP1–TP2.

TROUBLE/SYMPTOM

Low Z trip level is incorrect

PROBABLE CAUSE	SOLUTION
1. REM Board TP1–TP2.	1. Check U2B, R15, U4, T2, L1 (tuning), U6, voltage at

TROUBLE/SYMPTOM

Threshold shift when generator is activated.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check the shield can ground. U4, pin 1 output frequency U5 rise time 20 nanoseconds

TROUBLE/SYMPTOM

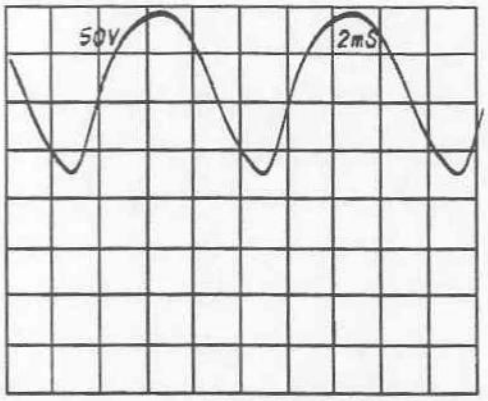
Low Hysterisis.

PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check oscillation on supplies and noise on TP1 10 mV.

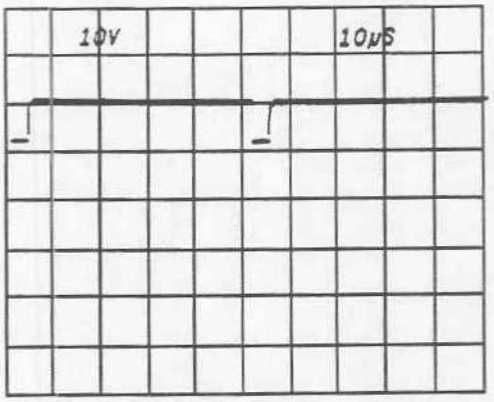
TROUBLE/SYMPTOM

REM patient return electrode connector does not activate REM mode, or conventional patient return electrode connector does not activate low impedance REM mode.

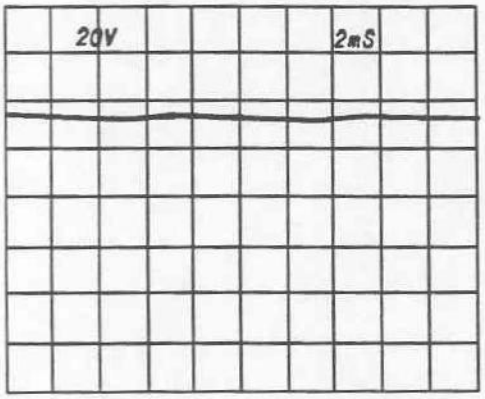
PROBABLE CAUSE	SOLUTION
1. REM Board	1. Check front panel switch and wiring, and U3 on REM Board.



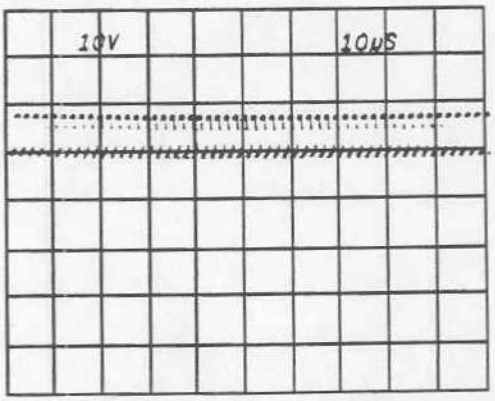
+200V SUPPLY (A9) C4 CUT MODE, FULL OUTPUT



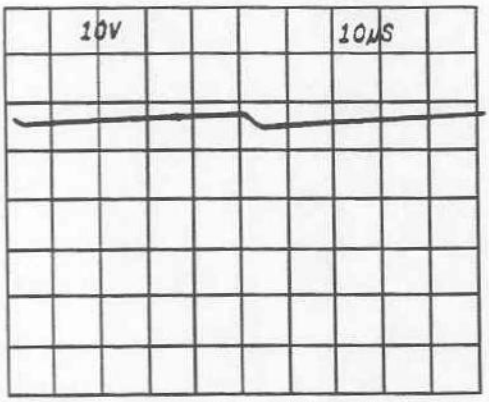
MULTIBOARD (A3) U1, PIN 3, ANY MODE



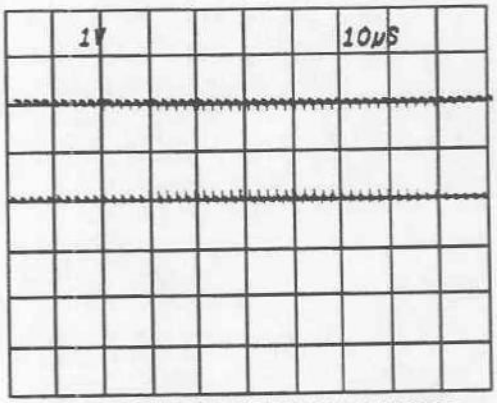
+35V SUPPLY (A9) C1 CUT MODE, FULL OUTPUT



MULTIBOARD (A3) Q2 COLLECTOR, ANY MODE

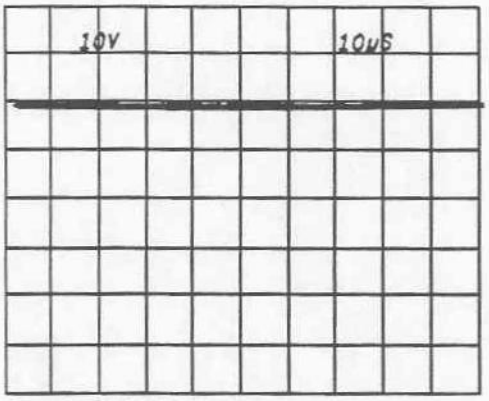


MULTIBOARD (A3) U1 PIN 2, 6, ANY MODE

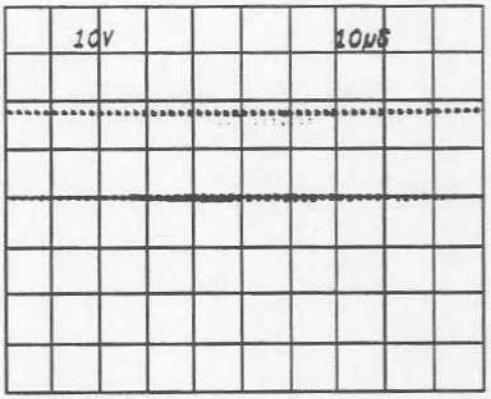


MULTIBOARD (A3) Q4 BASE, ANY MODE

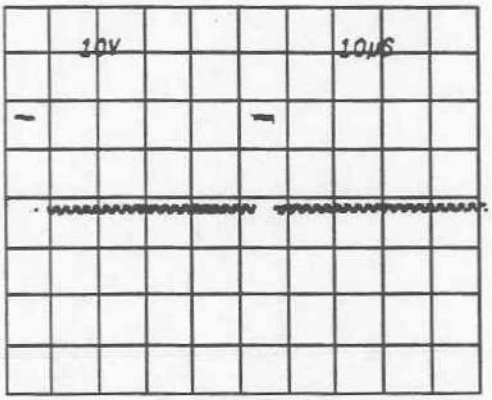
Figure 5 – SSE2L Waveforms



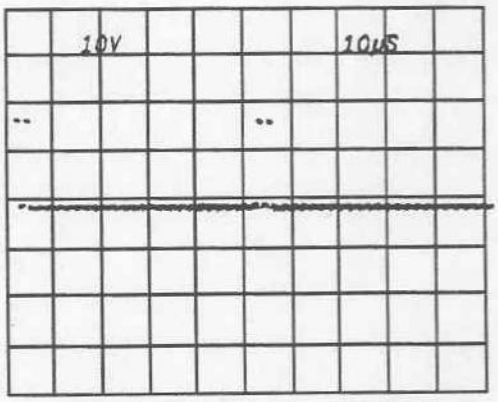
MULTIBOARD (A3) Q7 COLLECTOR, CUT MODE



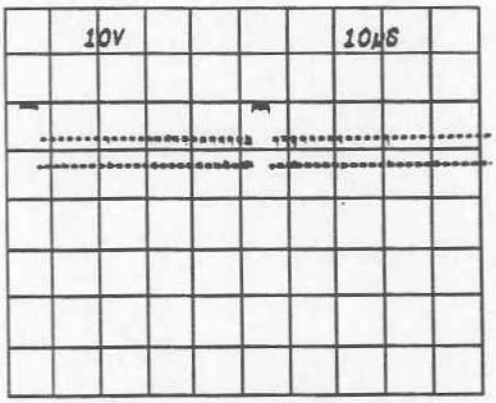
MULTIBOARD (A3) P2–F, CUT MODE



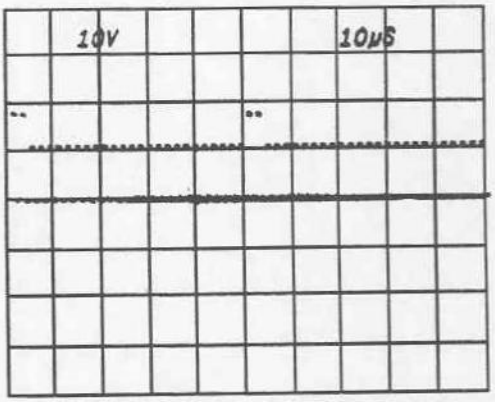
MULTIBOARD (A3) Q7 COLLECTOR, COAG MODE



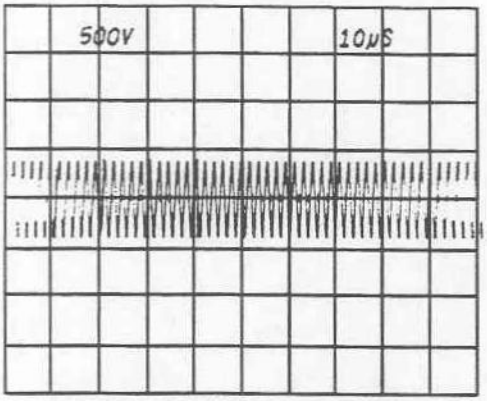
MULTIBOARD (A3) P2–D, COAG MODE



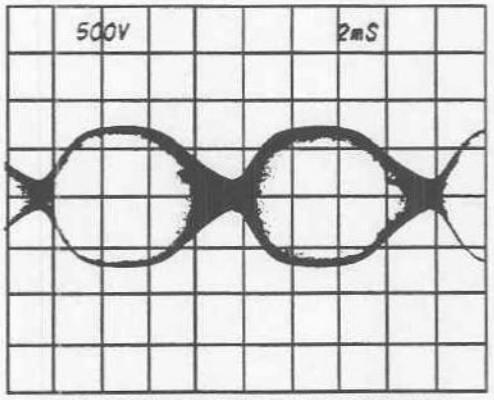
MULTIBOARD (A3) Q7 COLLECTOR, BLEND MODE



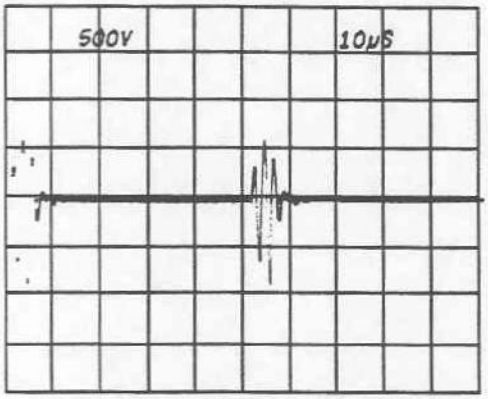
MULTIBOARD (A3) P2–F, BLEND MODE



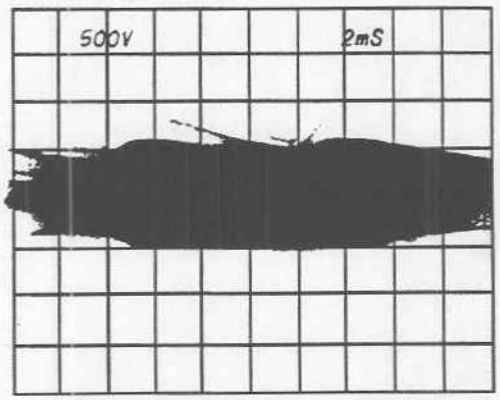
MONOPOLAR OUTPUT, 500 OHM LOAD
CUT MODE CONTROL SETTING 5



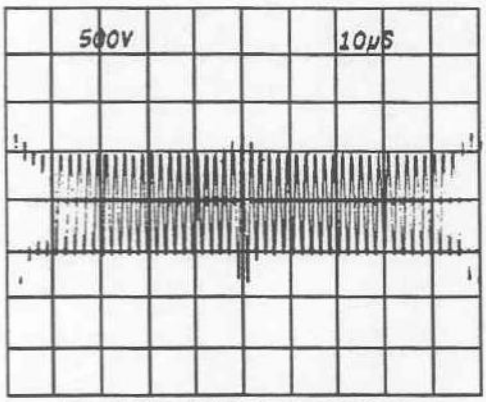
MONOPOLAR OUTPUT, 500 OHM LOAD
CUT MODE CONTROL SETTING 10



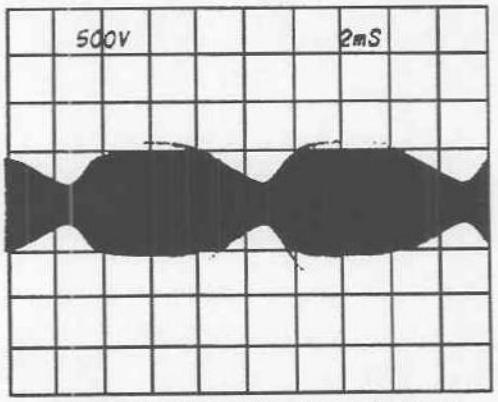
MONOPOLAR OUTPUT, 500 OHM LOAD
COAG MODE CONTROL SETTING 5



MONOPOLAR OUTPUT, 500 OHM LOAD
COAG MODE CONTROL SETTING 5



MONOPOLAR OUTPUT, 500 OHM LOAD
BLEND MODE CONTROL SETTING 5



MONOPOLAR OUTPUT, 500 OHM LOAD
BLEND MODE CONTROL SETTING 5

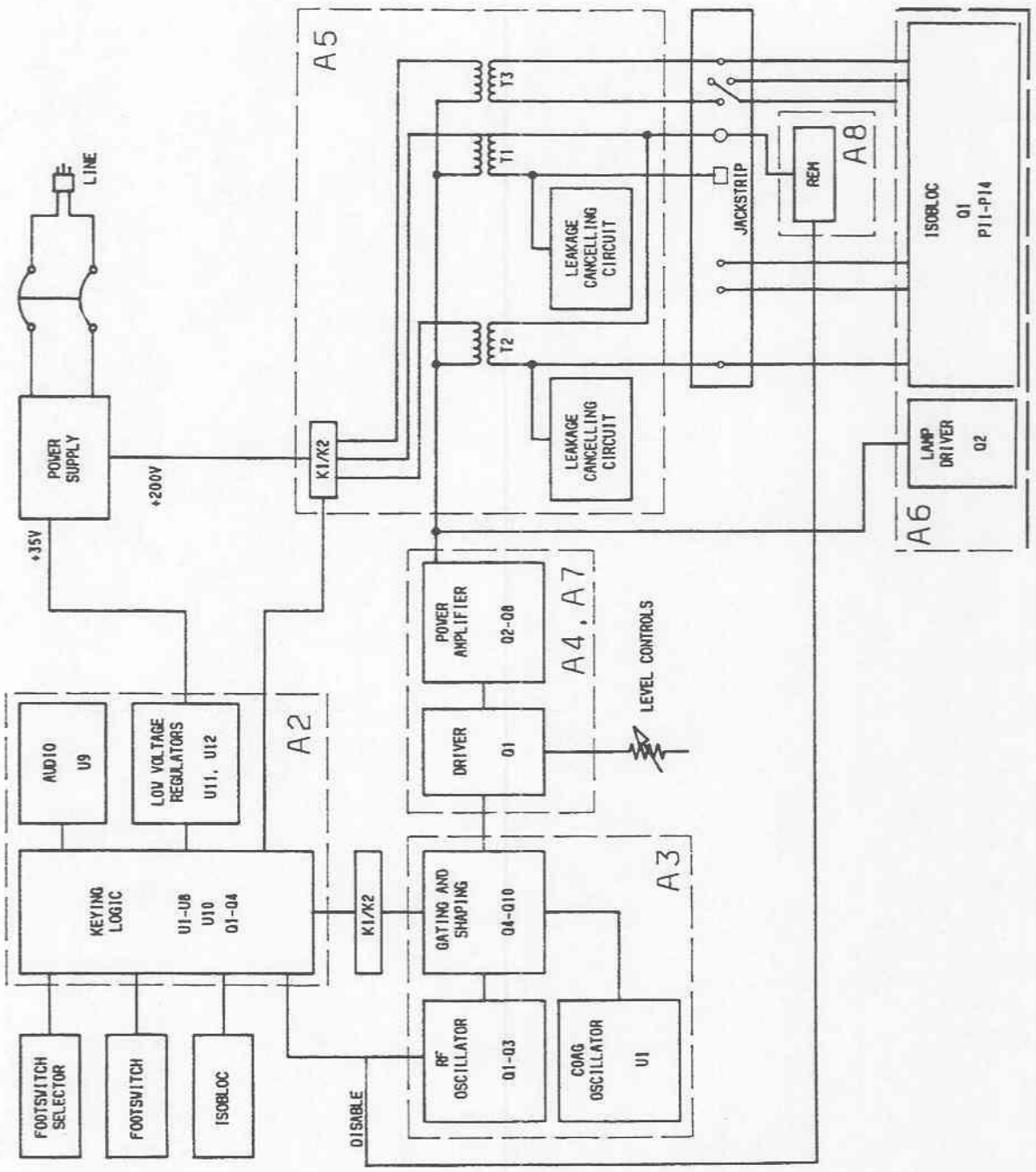


Figure 6 – SSE2L BLOCK DIAGRAM

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SECTION 7 —
ASSEMBLIES AND SCHEMATICS

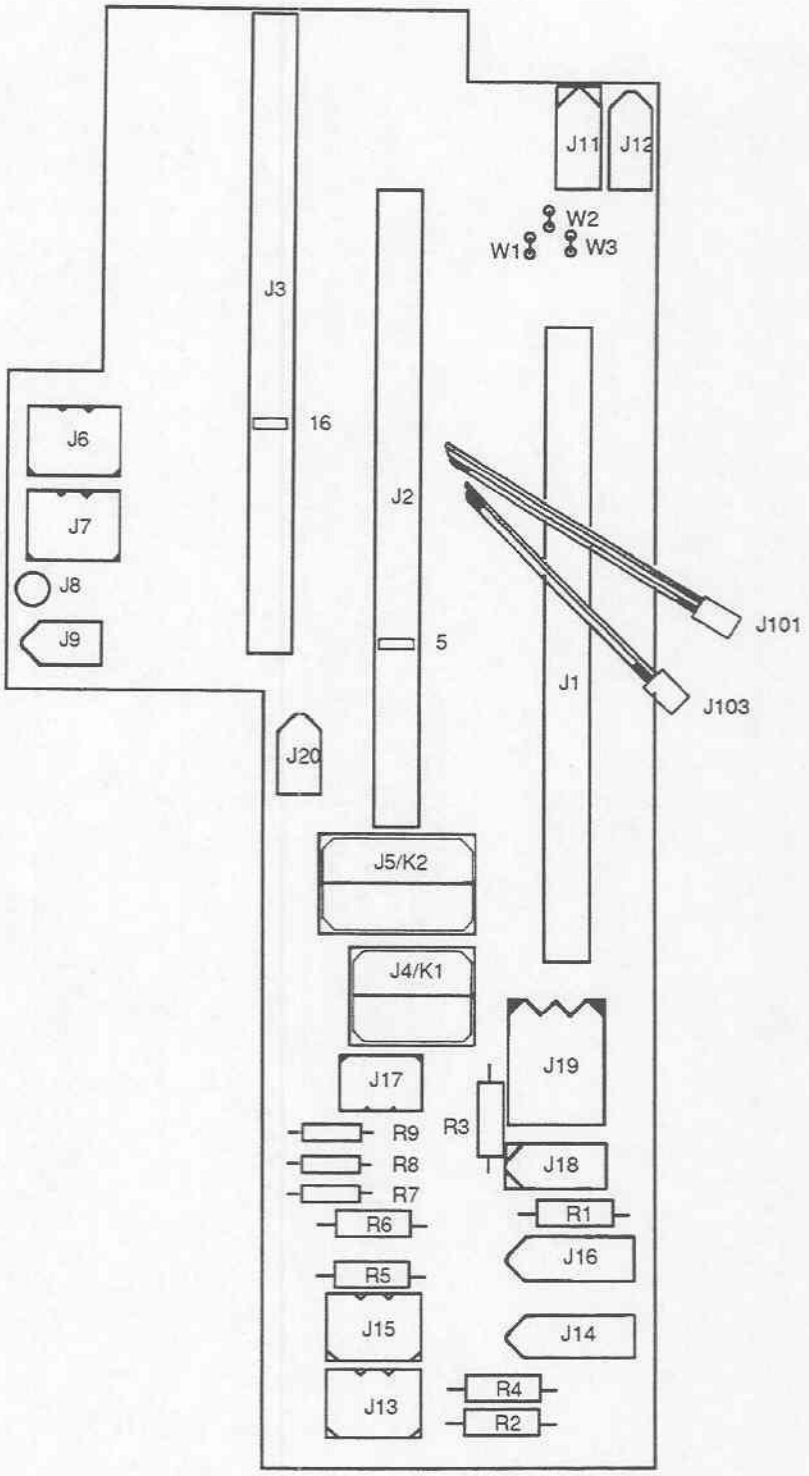

Figure 7 – Master Board (A1)

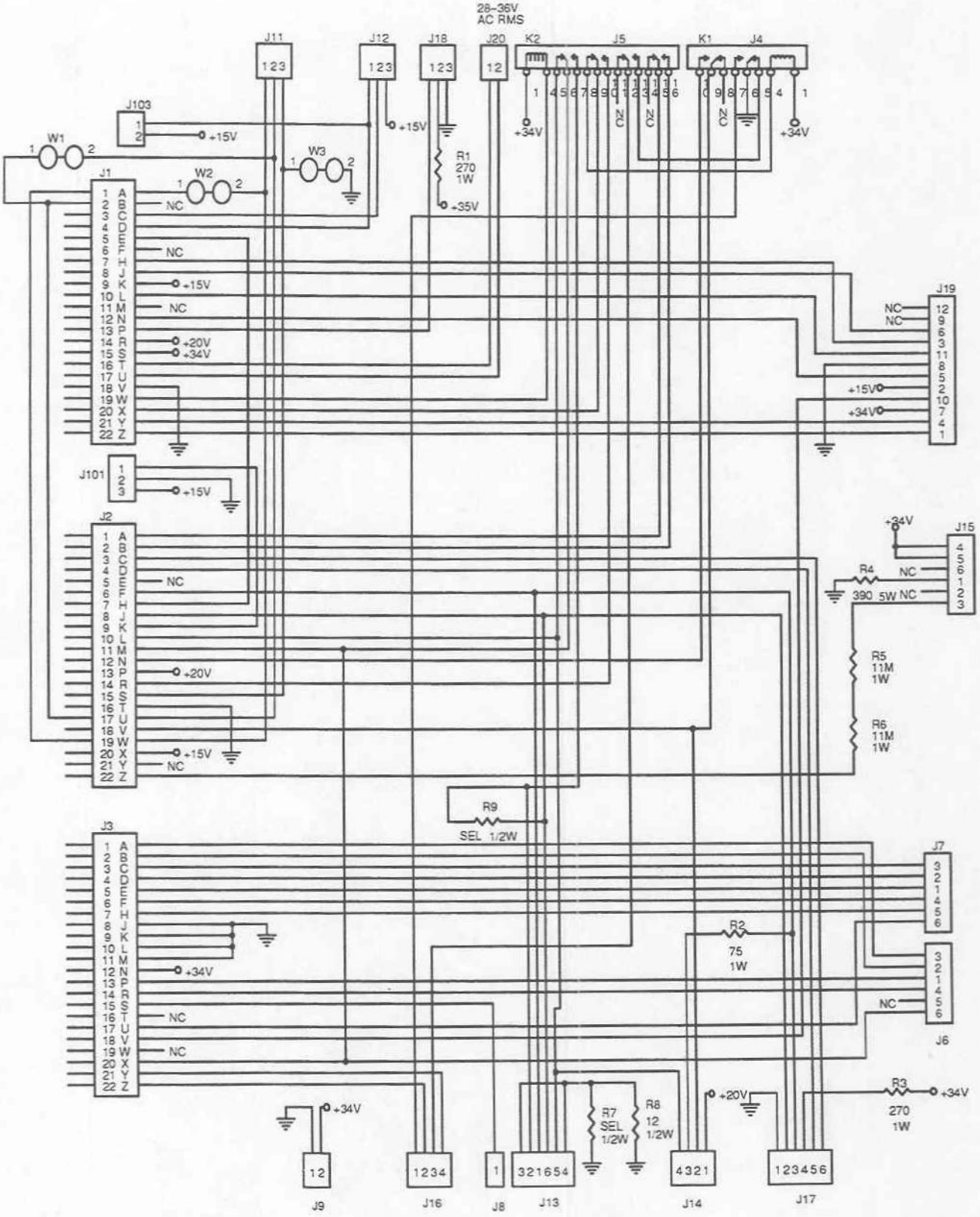

Figure 8 – Master Board Schematic (A1)

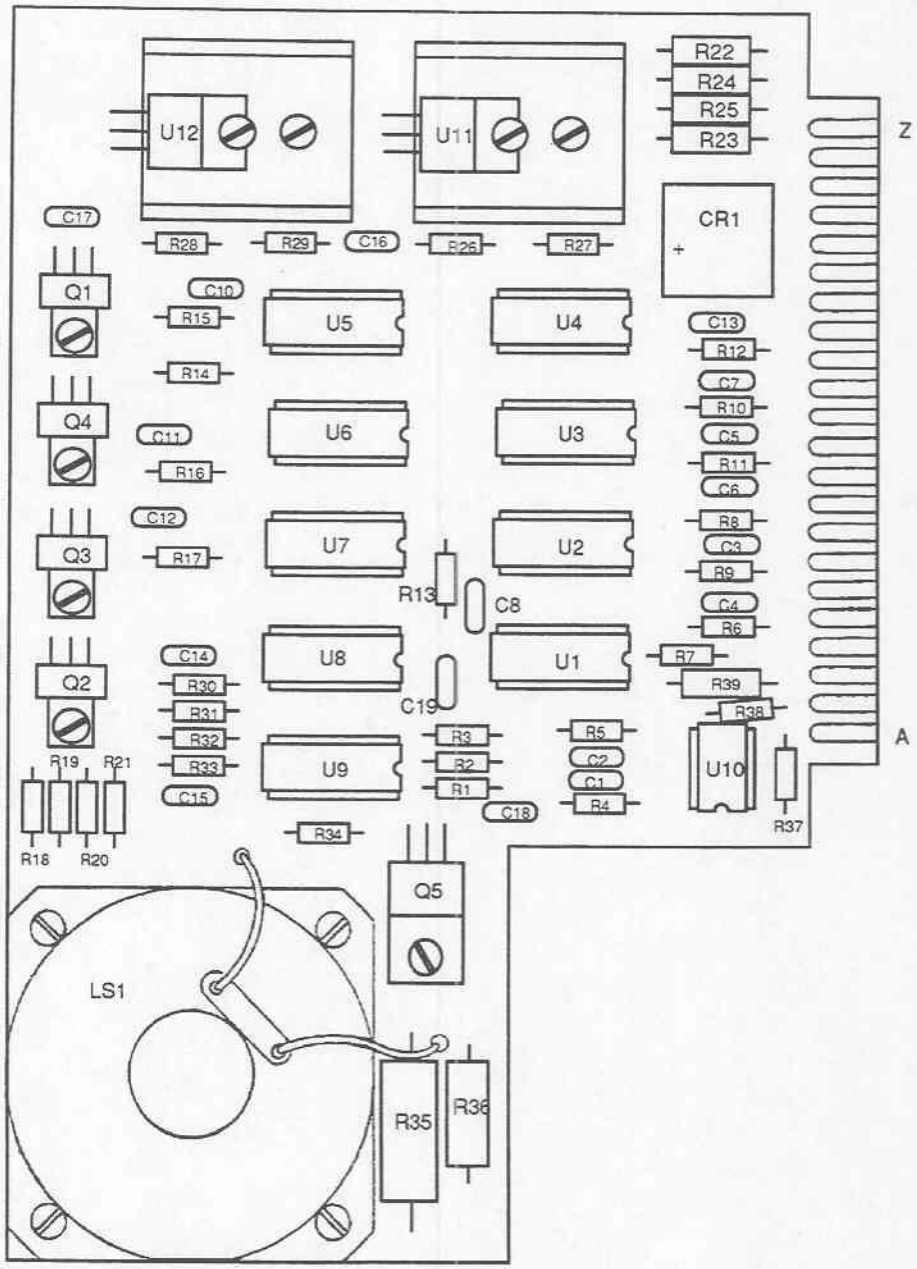

Figure 9 – Logic Board (A2)

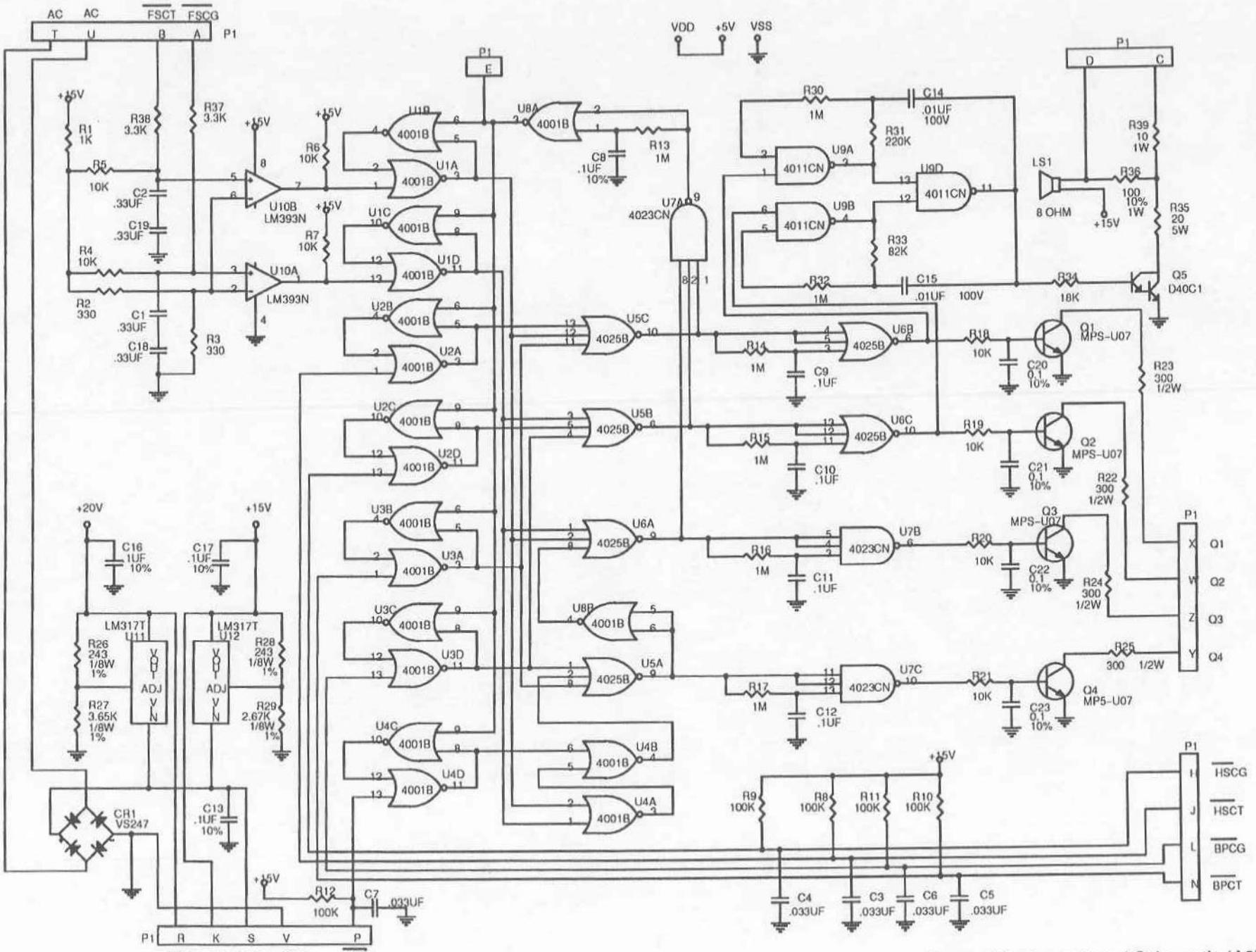

Figure 10 – Logic Board Schematic (A2)

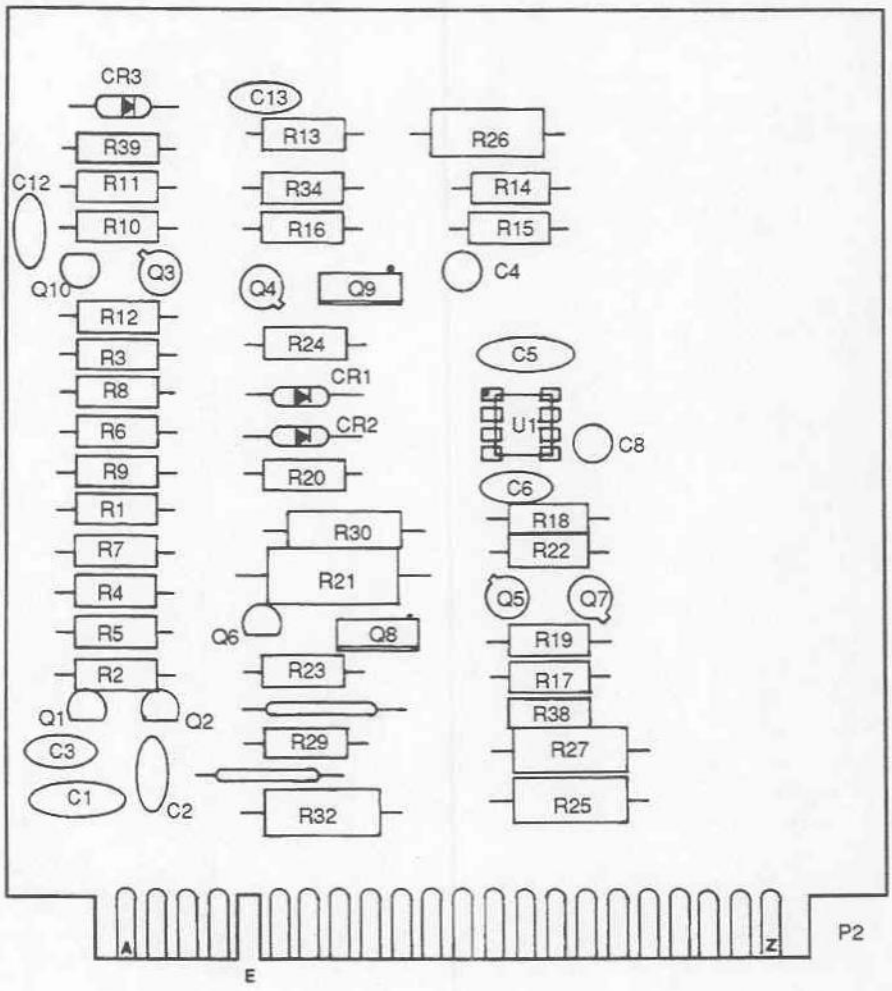

Figure 11 – Multivibrator Board (A3)

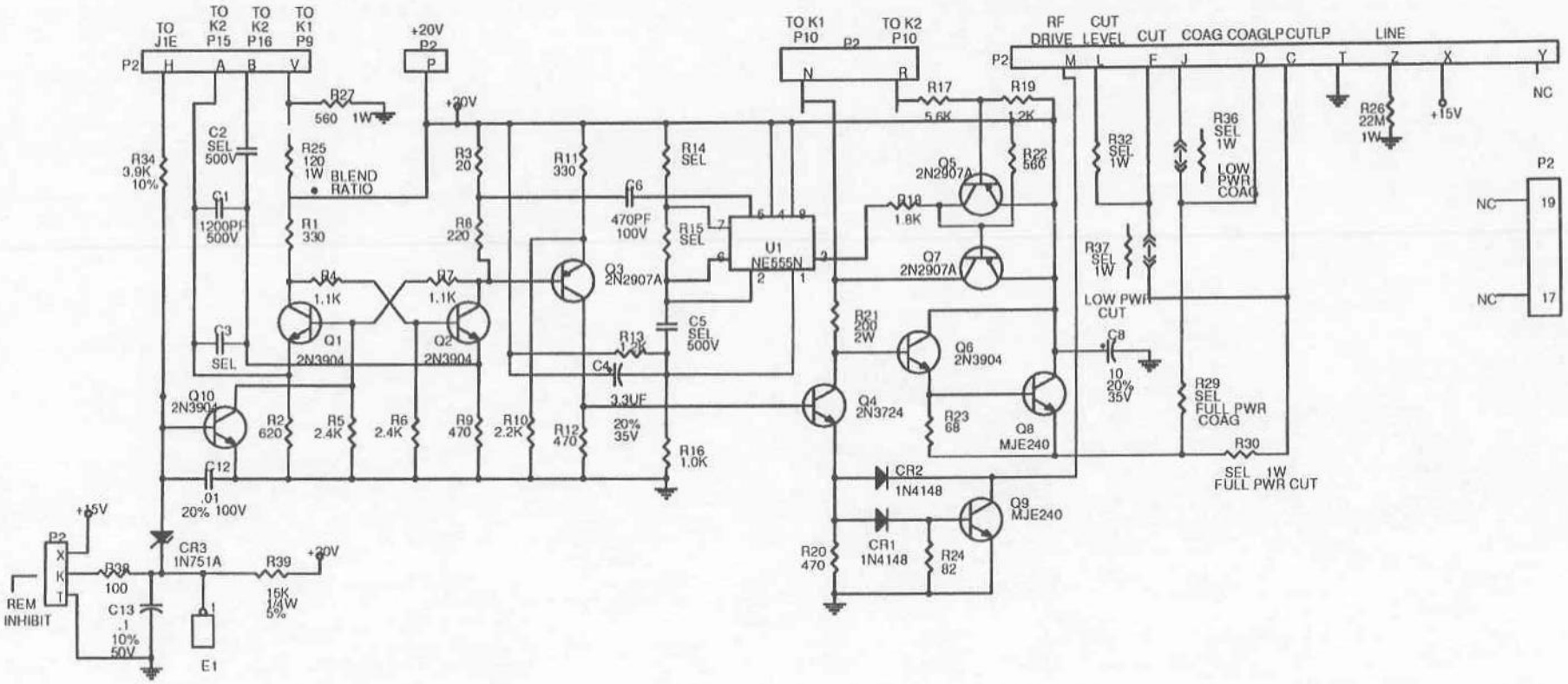

Figure 12 – Multivibrator Board Schematic (A3)

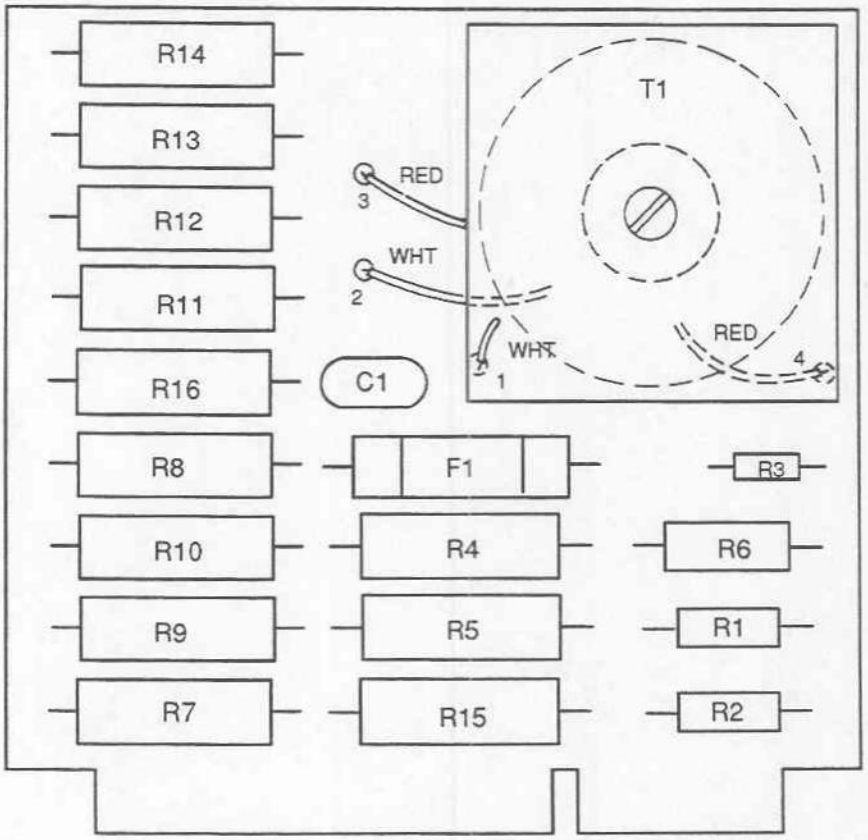

Figure 13 – Limit Resistor Board (A4)

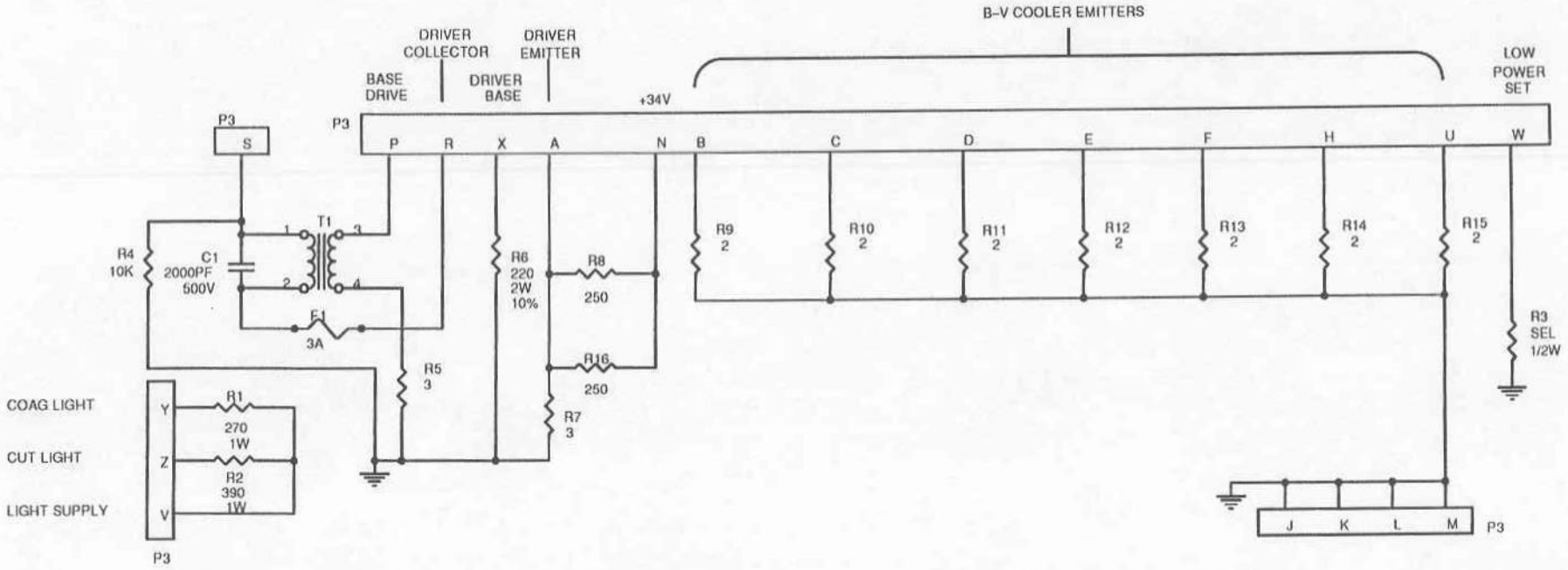

Figure 14 – Limit Resistor Board Schematic (A4)

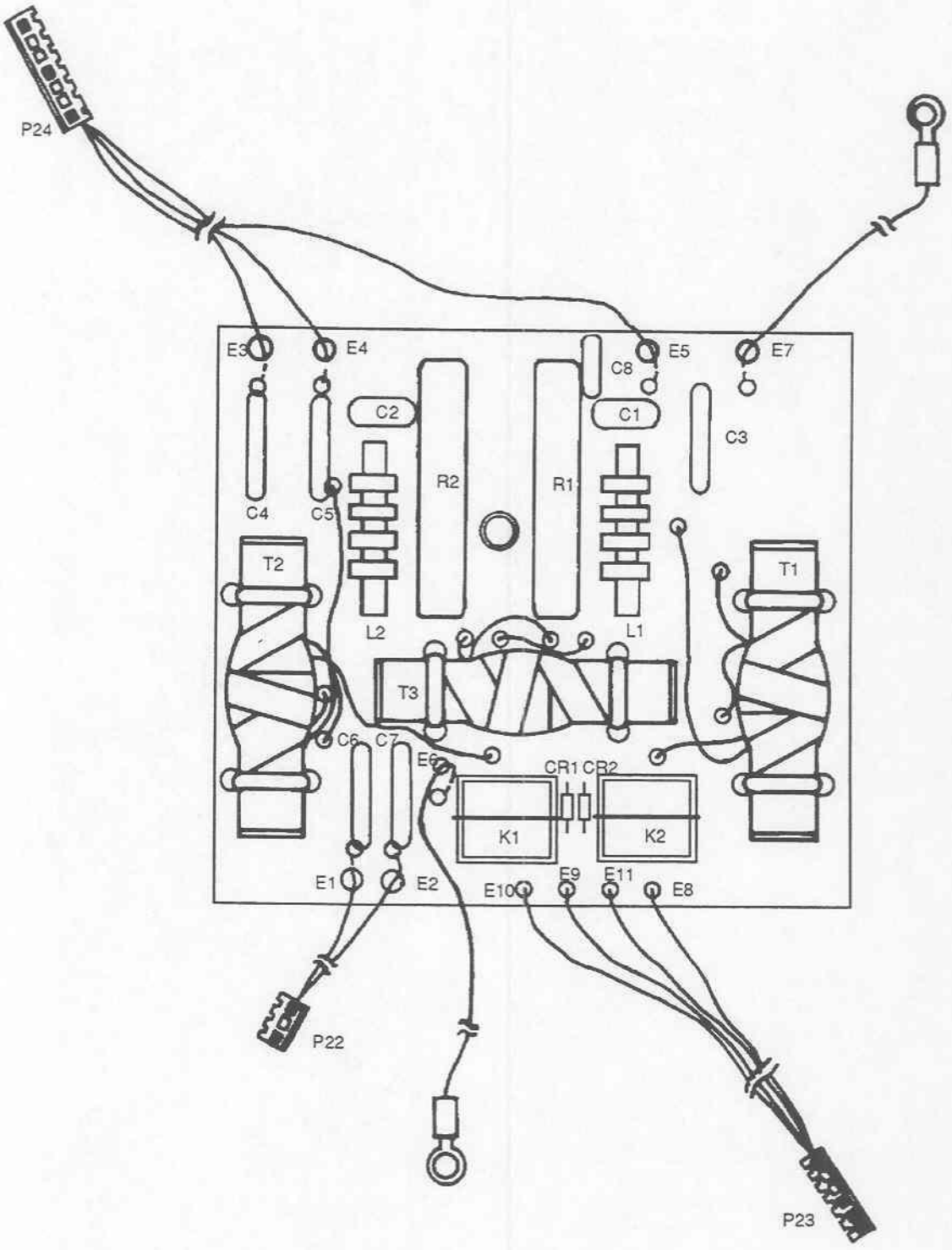

Figure 15 – Output Board (A5)

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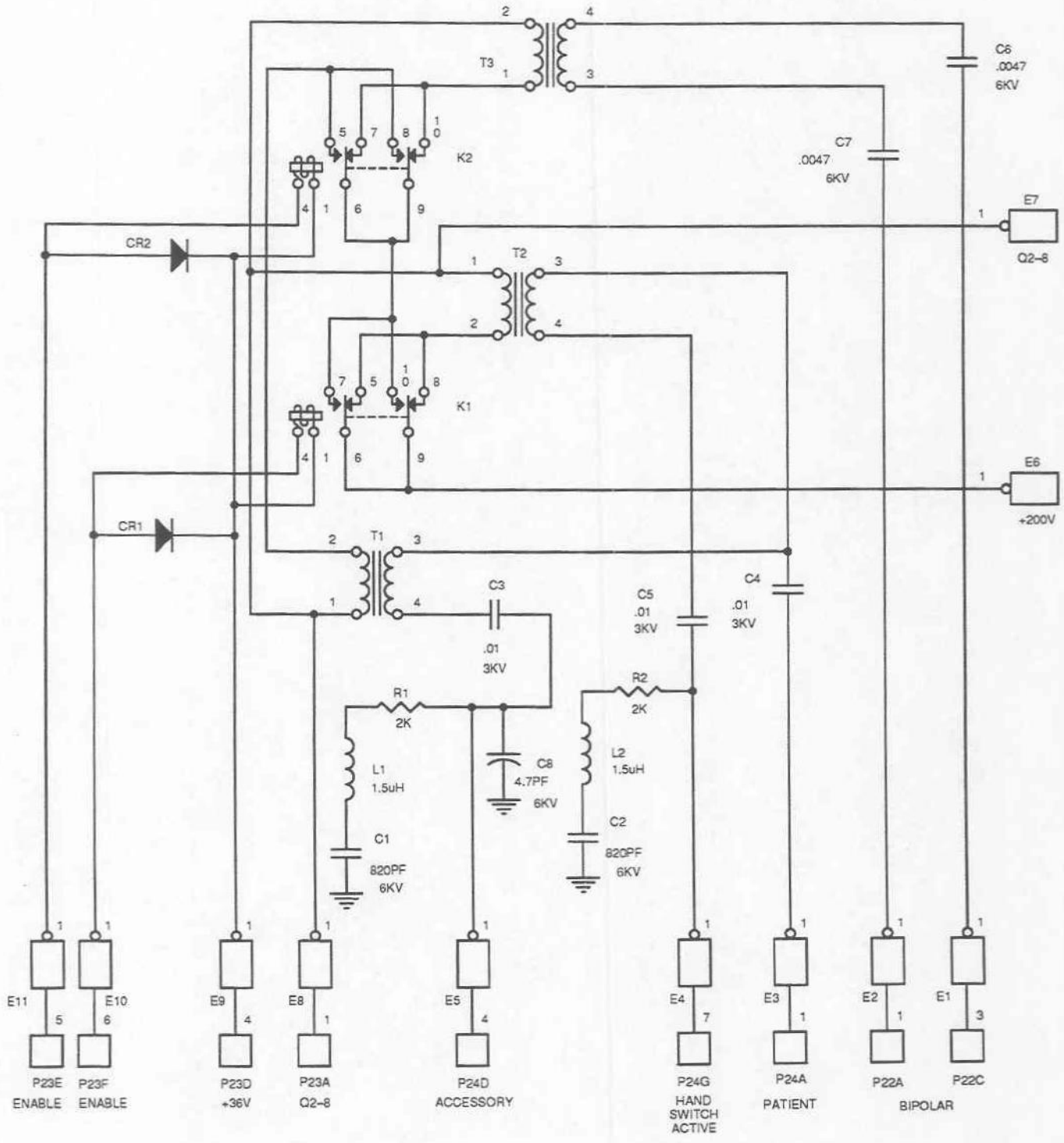


Figure 16 – Output Board Schematic (A5)

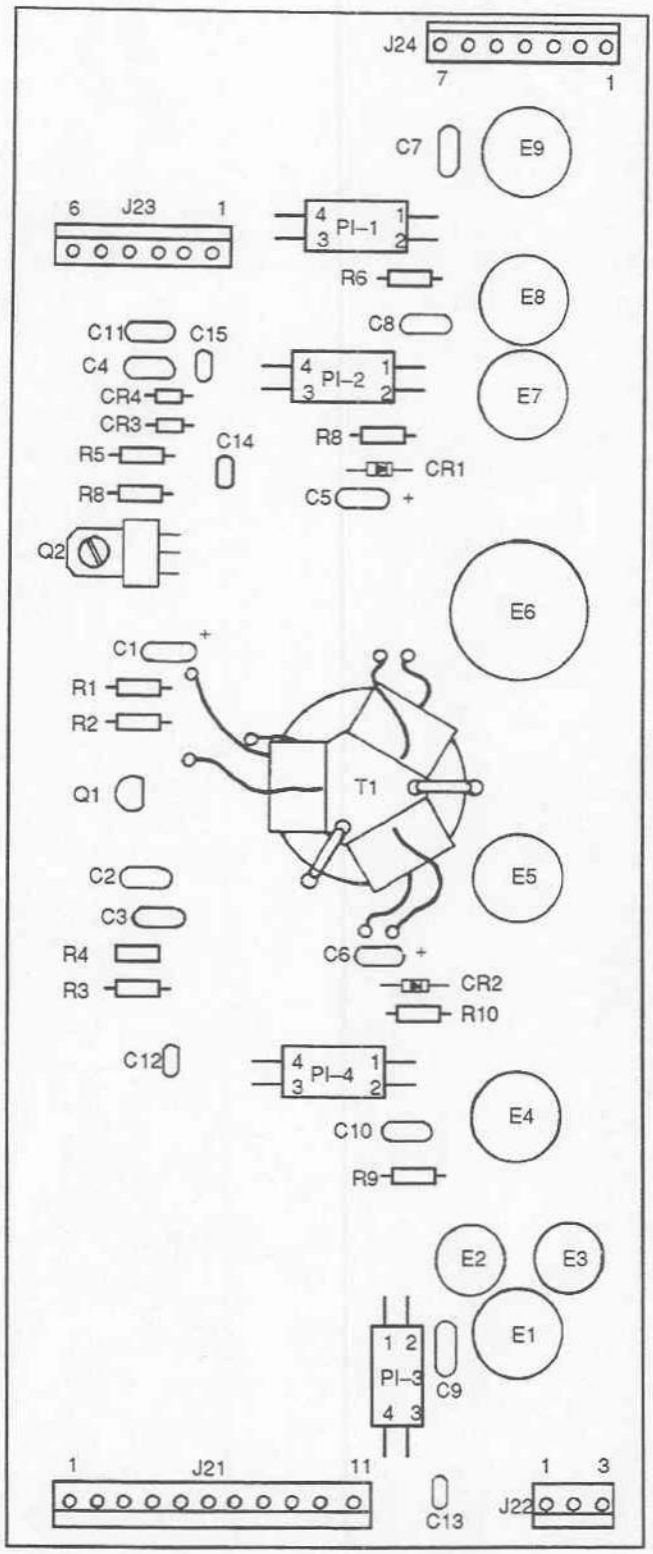


Figure 17 – IsoBloc Board (A6)

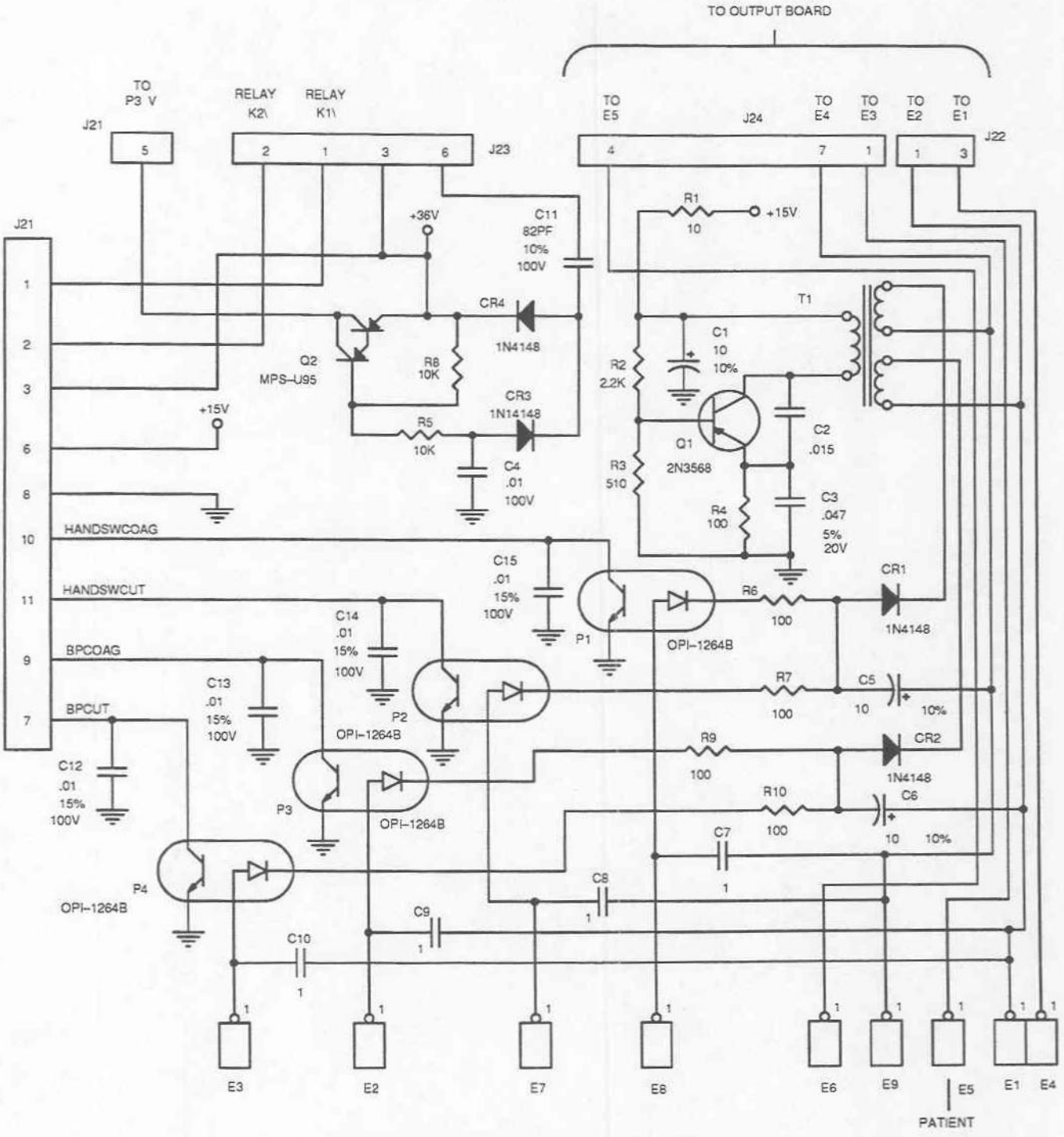


Figure 18 – IsoBloc Board Schematic (A6)

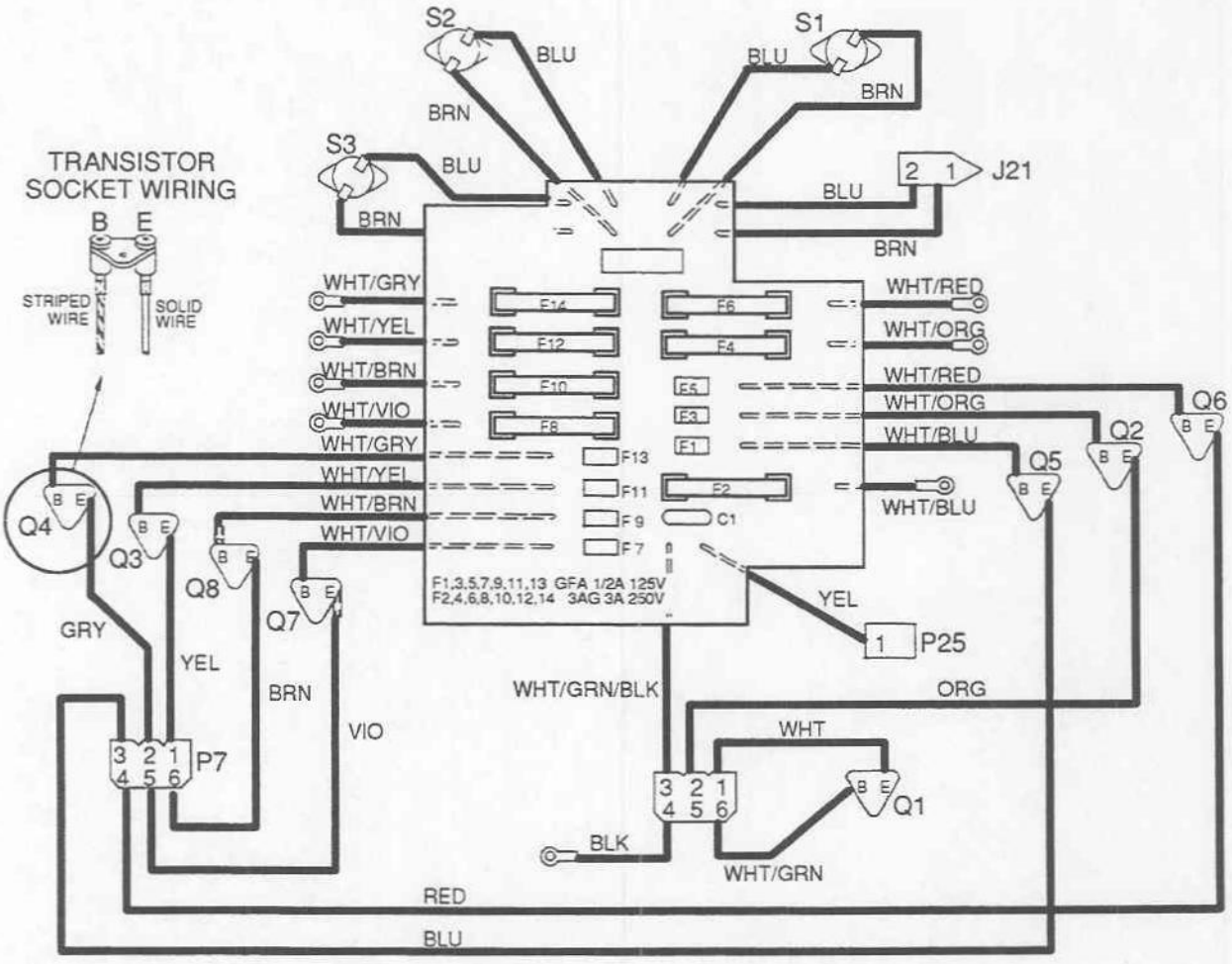


Figure 19 – Fuse Board (A7)

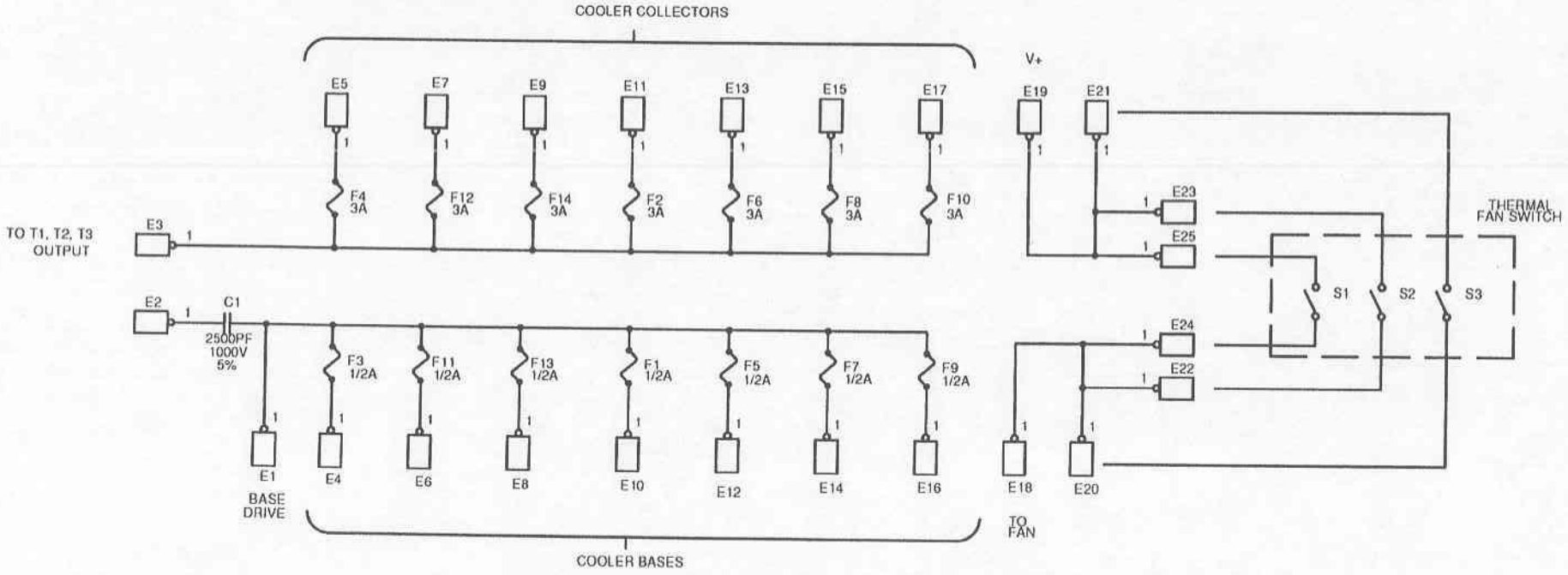


Figure 20 – Fuse Board Schematic (A7)

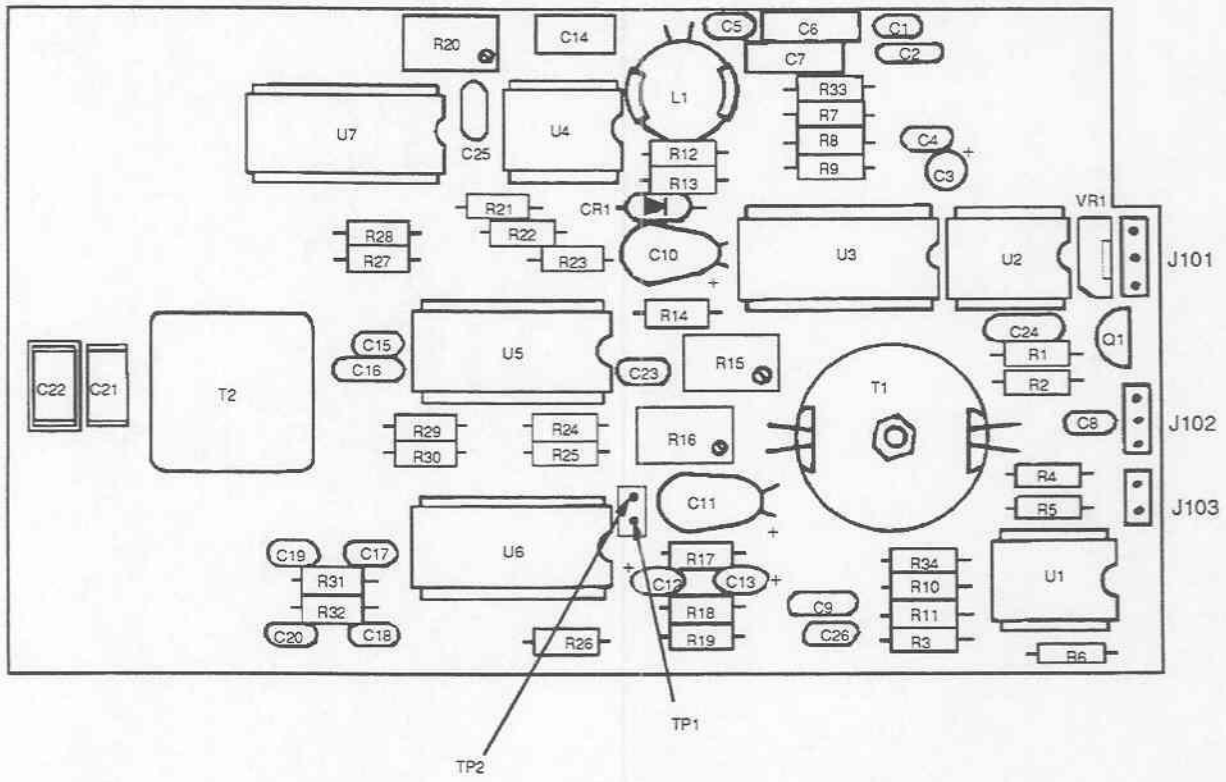


Figure 21 – REM Board (A8)

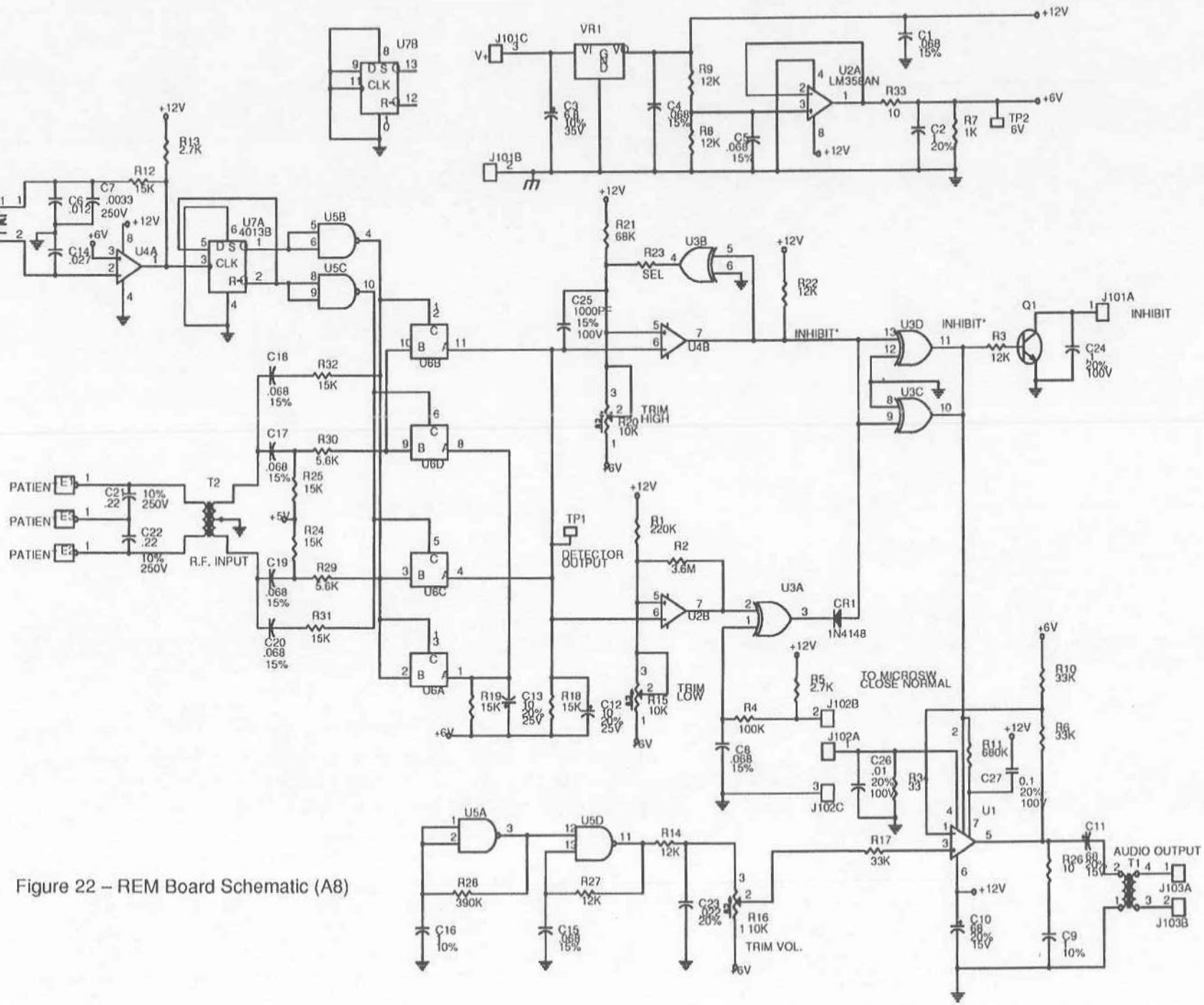


Figure 22 – REM Board Schematic (A8)

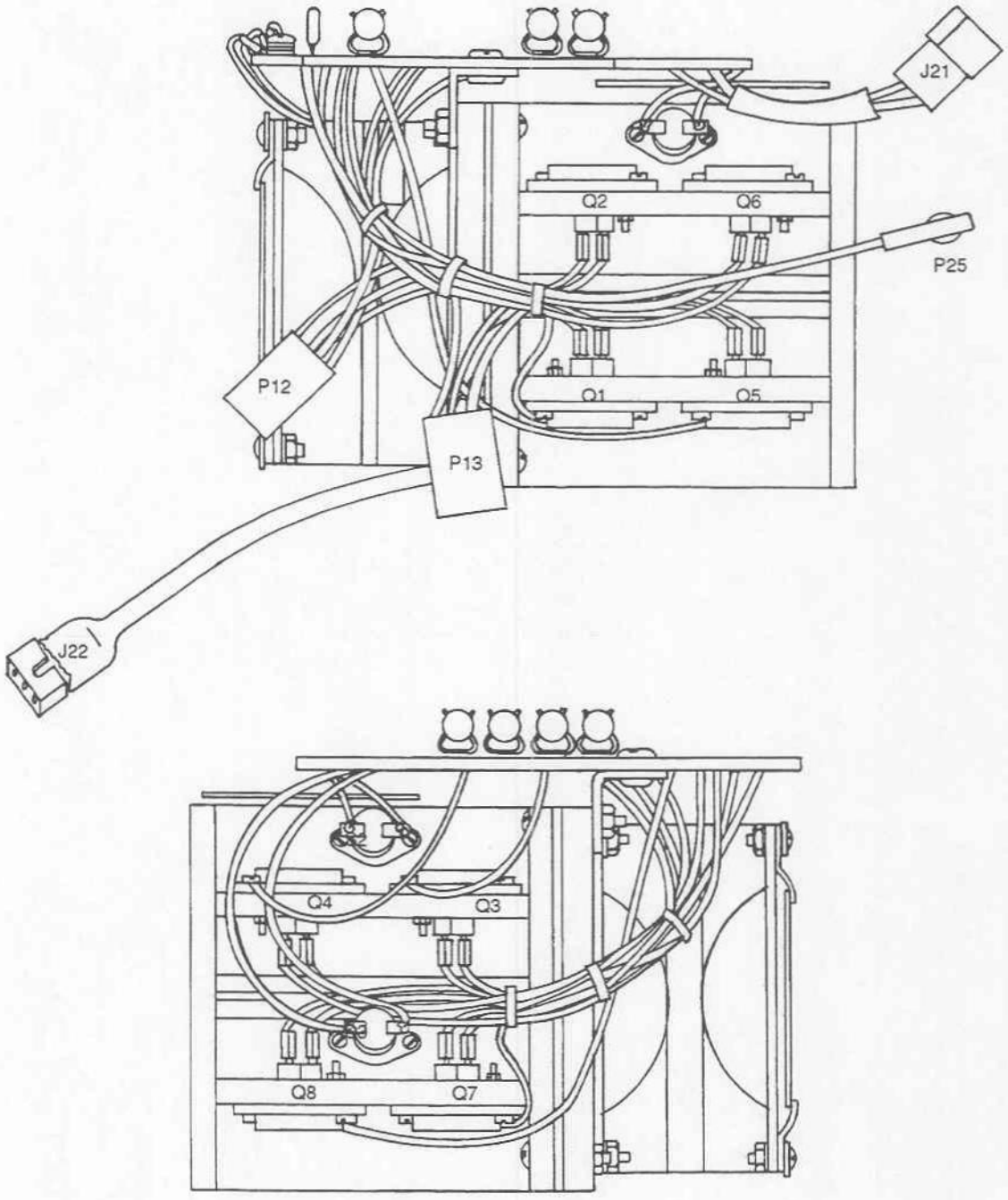
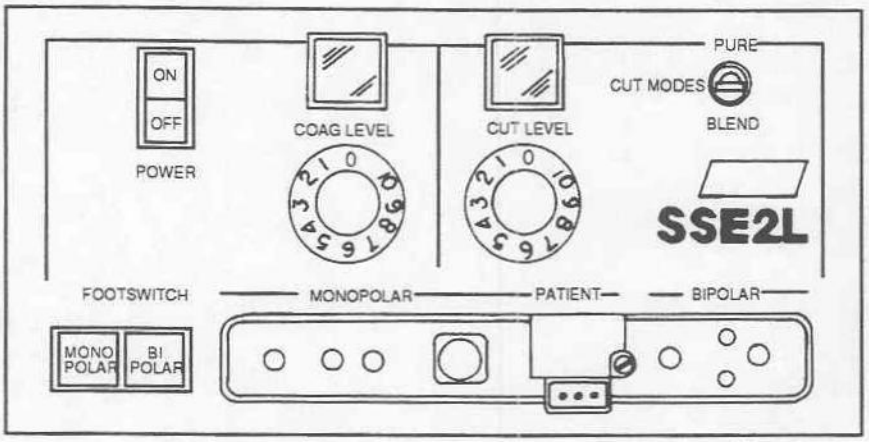


Figure 23 – Cooler Assembly (A7)



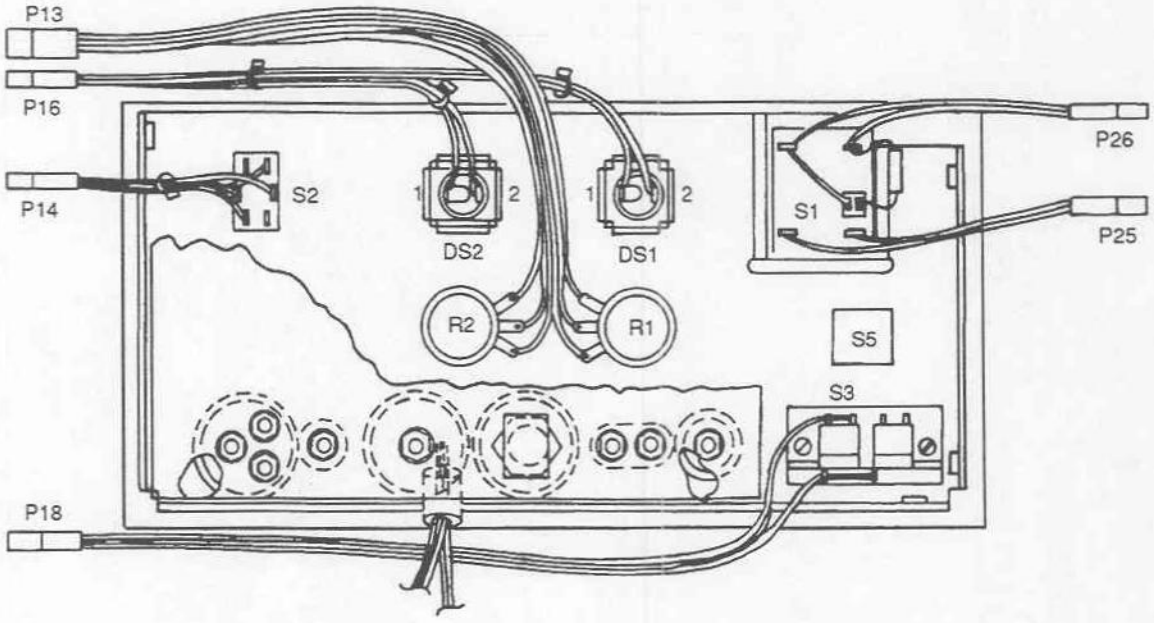


Figure 24 – Front Panel Assembly (A9)

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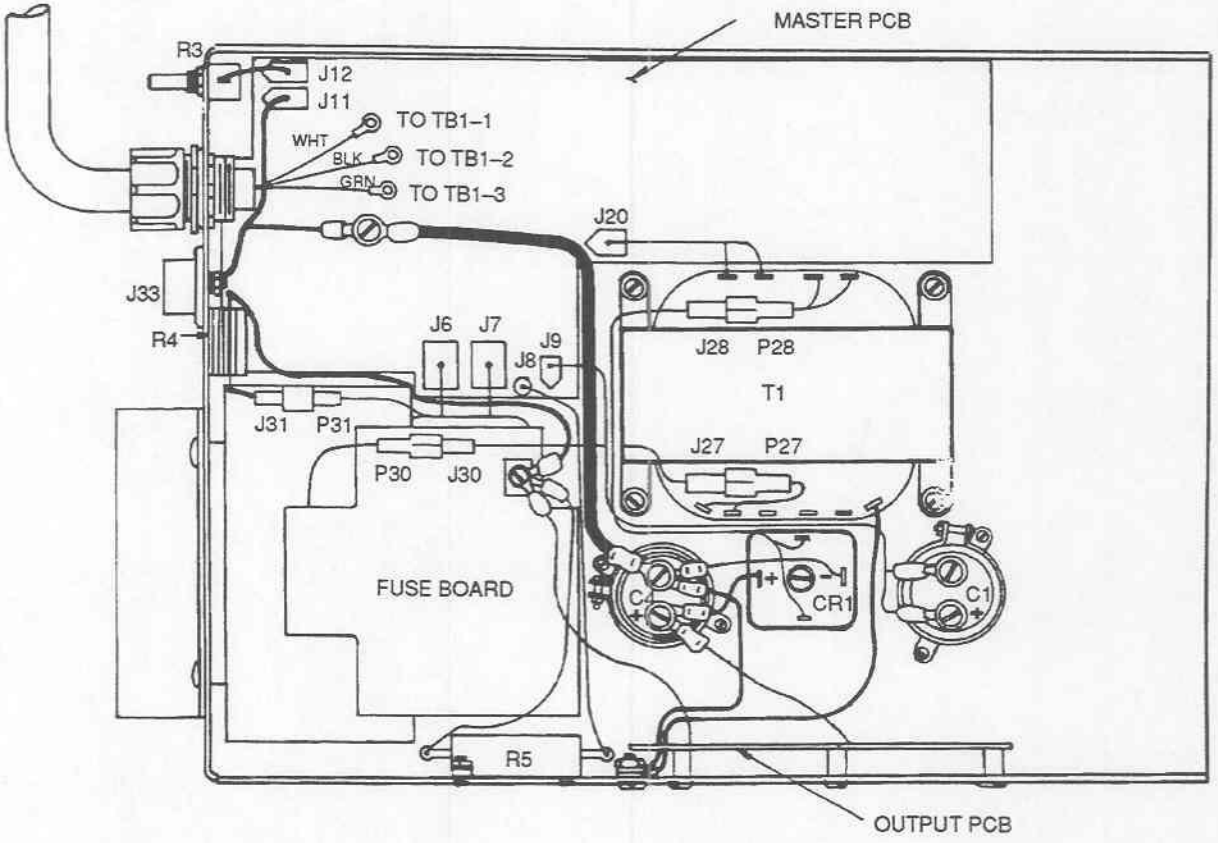

Figure 25 – Chassis Assembly (A9)

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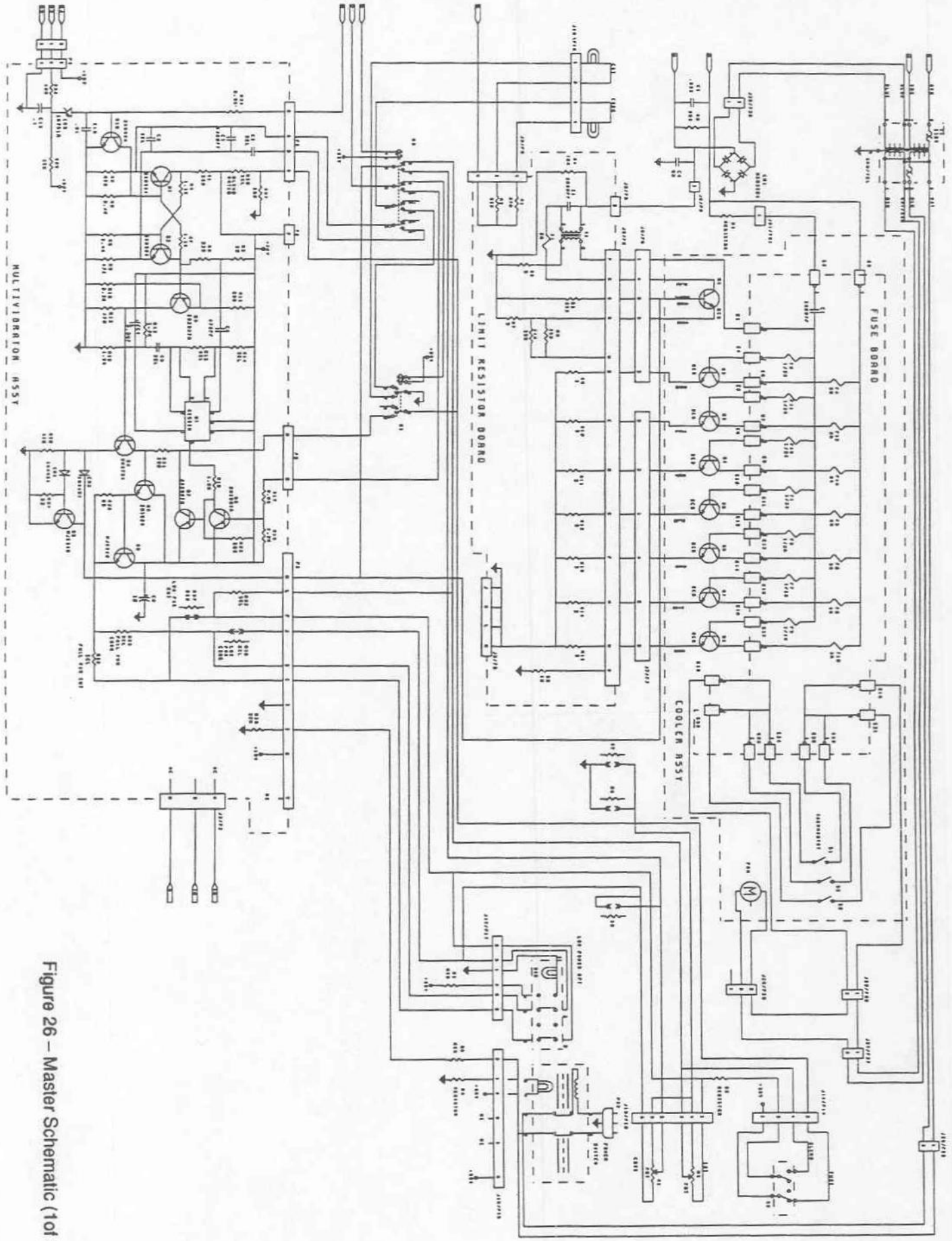

Figure 26 – Master Schematic (1of 3)

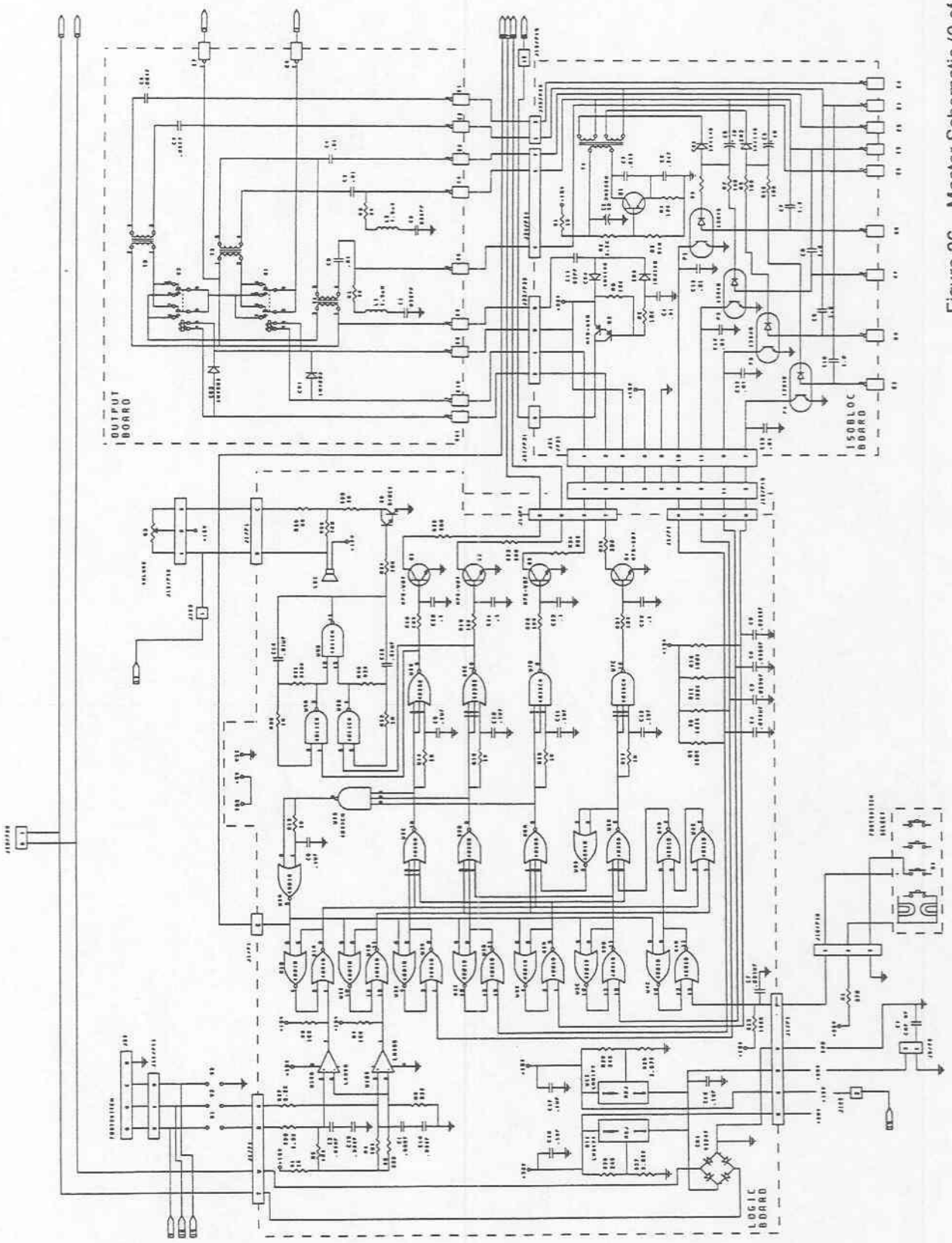

Figure 26 – Master Schematic (2 of 3)

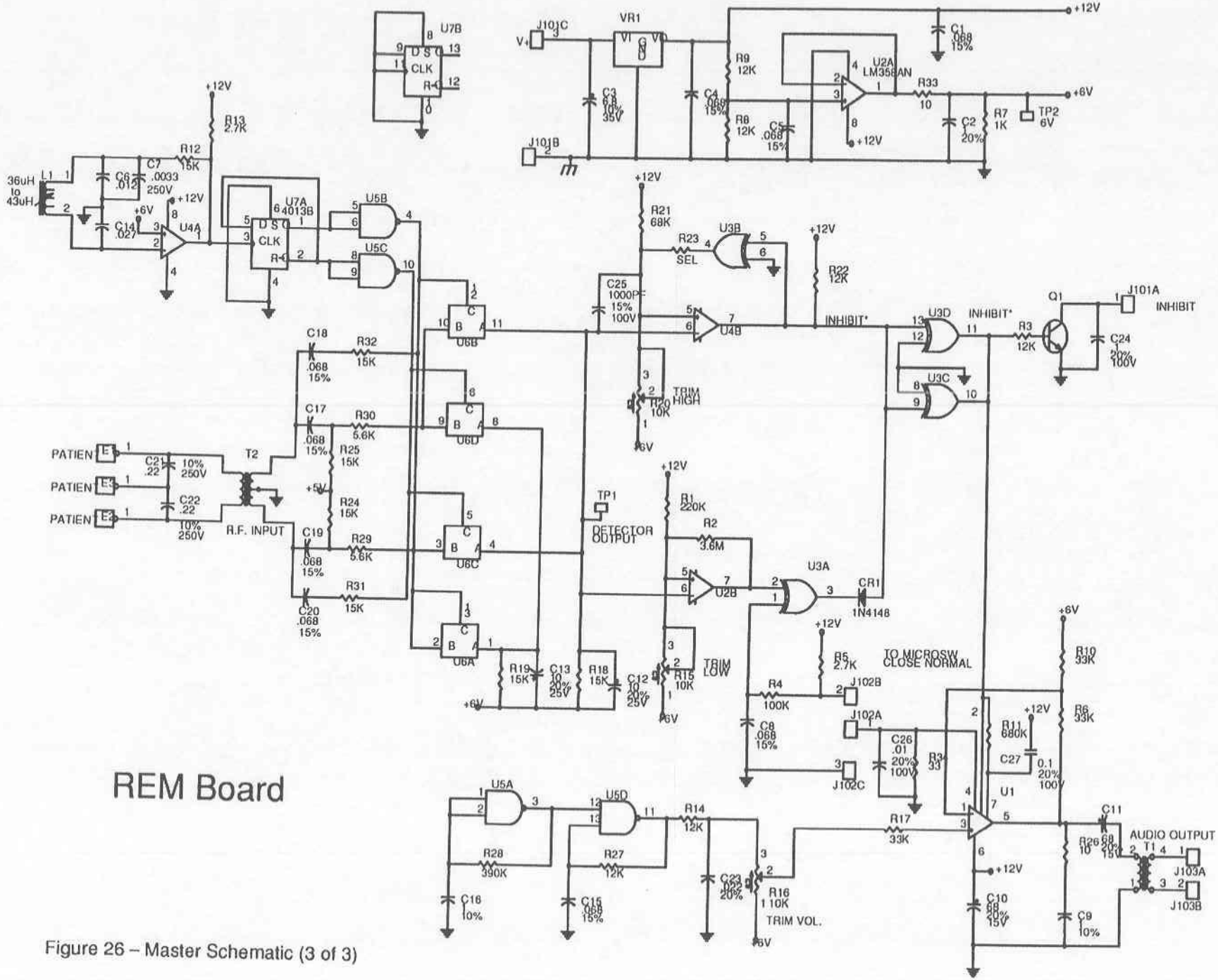

Figure 26 – Master Schematic (3 of 3)

SECTION 8 — PARTS LIST

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
MASTER BOARD (A1)		**201 103 002 H**
RESISTORS		
R1, R3	270 ohm ± 5%, 1W	234 022 049
R2	75 ohm ± 5%, 1W	234 022 036
R4	390 ohm ± 5%, 3 1/4W	234 015 072
R5,6	11Meg ohm ± 5%, 1W	234 022 160
R7,8	12 ohm ± 5%, 1/2W	234 014 031
R9	100–510 ohm ± 5%, 1/2W	234 014 SELECT
RELAYS		
K1	AZ–420–70–40LUS	230 005 007
K2	AZ–421–70–10LUS	230 005 006
LOGIC BOARD (A2)		**201 102 002 D**
RESISTORS		
R1	1K ohm ± 5%, 1/4W	234 024 063
R2, 3	330 ohm ± 5%, 1/4W	234 024 051
R4–7,18–21	10K ohm ± 5%, 1/4W	234 024 087
R8–12	100K ohm ± 5%, 1/4W	234 024 111
R13–17,30,32	1Meg ohm ± 5%, 1/4W	234 024 135
R22–25	300 ohm ± 5%, 1/2W	234 014 094
R26,28	243 ohm ± 1%, 1/8W	234 201 230
R27	3.65K ohm ± 1%, 1/8W	234 201 343
R29	2.67K ohm ± 1%, 1/8W	234 201 330
R31	220K ohm ± 5%, 1/4W	234 024 119
R33	82K ohm ± 5%, 1/4W	234 024 109
R34	18K ohm ± 5%, 1/4W	234 024 093
R35	20 ohm ± 5%, 5W	234 027 034
R36	100 ohm ± 10%, 1W	234 004 027
R37, 38	3.3K ohm ± 5%, 1/4W	234 024 075
R39	10 ohm ± 5%, 1W	234 022 015
CAPACITORS		
C1,2,18,19	.33 µf ± 20%, 50V	204 118 011
C3–7	.033 µf ± 20%, 50V	204 118 004
C8–12,13,16,17	.1 µf ± 10%, 50V	204 200 111
C14,15	.01 µf ± 20%, 100V	204 049 001

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
LOGIC BOARD (A2)		**201 102 002 D**
INTEGRATED CIRCUITS		
U1–4,8	4001B	210 210 001
U5,6	4025B	210 210 025
U7	4023CN	210 002 000
U9	4011CN	210 003 000
U10	LM393N	210 300 011
U11,12	LM317–T	210 400 001
DIODES		
CR1	VS247	239 006 000
TRANSISTORS		
Q1–4	MPS–U07	239 054 000
Q5	D40C1	239 037 001
MISCELLANEOUS		
LS1	Speaker 8 ohm	241 003 001
MULTIVIBRATOR BOARD (A3)		**201 108 006 B**
RESISTORS		
R1,11	330 ohm ± 5%, 1/2W	234 014 036
R2	620 ohm ± 5%, 1/2W	234 014 040
R3	20 ohm ± 5%, 1/2W	234 014 074
R4,7	1.1K ohm ± 5%, 1/2W	234 014 022
R5,6	2.4K ohm ± 5%, 1/2W	234 014 018
R8	220 ohm ± 5%, 1/2W	234 014 034
R9,12,20	470 ohm ± 5%, 1/2W	234 014 038
R10	2.2K ohm ± 5%, 1/2W	234 014 103
R13,19	1.2K ohm ± 5%, 1/2W	234 014 041
R14	18–27K ohm ± 5%, 1/2W	234 014 SELECT
R15	1.6K–2.2K ohm ± 5%, 1/2W	234 014 SELECT
R16	1.0K ohm ± 5%, 1/2W	234 014 001
R17	5.6K ohm ± 5%, 1/2W	234 014 014
R18	1.8K ohm ± 5%, 1/2W	234 014 042
R21	200 ohm ± 5%, 2W	234 001 034
R22	560 ohm ± 5%, 1/2W	234 014 039
R23	68 ohm ± 5%, 1/2W	234 014 032
R24	82 ohm ± 5%, 1/2W	234 014 033
R25	120–330 ohm ± 5%, 1W	234 022 SELECT
R26	22M ohm ± 10%, 1W	234 004 084
R27	560 ohm ± 5%, 1W	234 022 057
R28	3.3K ohm ± 5%, 1/2W	234 014 025
R29	1.5–12 ohm ± 5%, 1/2W	234 014 SELECT
R30	62–150 ohm ± 5%, 1W	234 022 SELECT

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
MULTIVIBRATOR BOARD (A3)		**201 108 006 B**
RESISTORS		
R31	180 ohm ± 10%, 1W	234 004 030
R32	75–330 ohm ± 5%, 1W	234 022 SELECT
R34	3.9K ohm ± 10%, 1/2W	234 014 011
R38	100 ohm ± 5%, 1/4W	234 024 039
R39	15K ohm ± 5%, 1/4W	234 024 091
CAPACITORS		
C1	1200 pf ± 5%, 500V	204 105 028
C2	240 pf ± 5%, 500V	204 105 011
C3	390–620 pf ± 5%	204 105 SELECT
C4	3.3 µf ± 20%, 35V	204 104 045
C5	2400–2700 pf ± 5%, 500V	204 105 SELECT
C6	470 pf ± 5%, 100V	204 106 027
C7	180 pf ± 5%, 500V	204 105 008
C8	10 µf ± 20%, 35V	204 104 048
C9	22 µf ± 10%, 10V	204 111 003
C10,C12	.01 µf ± 20%, 100V	204 049 001
C11	0.1µf ± 20%, 100V	204 121 048
C13	0.1 µf ± 10%, 50V	204 200 111
INTEGRATED CIRCUITS		
U1	NE555N	210 006 000
U2	4001B	210 210 001
DIODES		
CR1,CR2	1N4451	239 050 000
CR3	1N751A	239 600 011
TRANSISTORS		
Q1,2,6,10	2N3904	239 015 000
Q3,5,7	2N2907A	239 016 000
Q4	2N3724	239 052 000
Q8,9	MJE240	239 039 000
MISCELLANEOUS		
SCR1	MCR 104	239 059 000
LIMIT RESISTOR BOARD (A4)		**201 109 002 B**
RESISTORS		
R1	270 ohm ± 5%, 1W	234 022 049
R2	390 ohm ± 5%, 1W	234 022 053
R3	6.8–10 ohm ± 5%, 1/2W	234 014 SELECT

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
LIMIT RESISTOR BOARD (A4)		**201 109 002 B**
R4	10K ohm ± 5%, 8W	234 000 012
R5,7	3 ohm ± 5%, 8W	234 000 004
R6	220 ohm ± 10%, 2W	234 002 002
R8,16	250 ohm ± 5%, 8W	234 000 018
R9,10,11,12,13,14,15	2 ohm ± 5%, 8W	234 000 003
CAPACITORS		
C1	2000 pf ± 5%, 500V	204 105 033
MISCELLANEOUS		
T1	Toroid Assy	202 188 000
F1	Fuse 3 amp 250V 3AG	215 019 021
OUTPUT BOARD (A5)		**201 101 005 A**
RESISTORS		
R1,2	2K ohm ± 10%, 20W	234 023 029
CAPACITORS		
C1,2	820 pf ± 20%, 6 kV	204 025 040
C3,4,5	.01 µf ± 20%, 3 kV	204 113 063
C6,7	.0047 µf ± 20%, 6 kV	204 025 050
C8	4.7 pf ± 20%, 6 kV	204 025 002
DIODES		
CR1,CR2	1N4002	239 091 002
MISCELLANEOUS		
K1,K2	Relay AZ420–70–4HUS	230 005 005
L1,L2	Inductor 1.5 mH	251 029 011
T1,T2	Transformer Assembly	202 700 052
T3	Transformer Assembly	202 700 053
IsoBloc BOARD (A6)		**201 100 002 C**
RESISTORS		
R1	10 ohm ± 5%, 1/4W	234 024 015
R2	2.2K ohm ± 5%, 1/4W	234 024 071
R3	510 ohm ± 5%, 1/4W	234 024 056
R4,6,7,9,10	100 ohm ± 5%, 1/4W	234 024 039
R5,8	10K ohm ± 5%, 1/4W	234 024 087

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
IsoBloc BOARD (A6)		**201 100 002 C**
CAPACITORS		
C1,5,6	10 µf ± 10%, 20V	204 055 002
C2	.015 µf ± 20%, 50V	204 118 002
C3	.047 µf ± 5%, 20V	204 200 107
C4	.01 µf ± 20%, 100V	204 049 001
C7–10	1 µf ± 20%, 50V	204 121 082
C11	82 pf ± 10%, 1000V	204 079 025
C12–15	.010 µf ± 15%, 100V	204 200 037
DIODES		
CR1–4	1N4148	239 014 000
TRANSISTORS		
Q1	2N3568	239 017 000
Q2	MPS–U95	234 078 000
MISCELLANEOUS		
PI–1,2,3,4	Photoisolator 1264B	239 750 019
T1	Toroid Assy	202 224 000
REM BOARD (A8)		**201 135 000 K**
RESISTORS		
R1	220K ohm ± 5%, 1/4W	234 024 119
R2	3.6M ohm ± 5%, 1/4W	234 024 147
R3,8,9,14,22,27	12K ohm ± 5%, 1/4W	234 024 089
R4	100K ohm ± 5%, 1/4W	234 024 111
R5,13	2.7K ohm ± 5%, 1/4W	234 024 073
R6,10,17	33K ohm ± 5%, 1/4W	234 024 099
R7	1K ohm ± 5%, 1/4W	234 024 063
R11	680K ohm ± 5%, 1/4W	234 024 131
R12,18,19,24,25,31,32	15K ohm ± 5%, 1/4W	234 024 091
R15,16,20	Trimpot, 10K	236 200 079
R21	68K ohm ± 5%, 1/4W	234 024 107
R23	1.6Meg ohm ± 5%, 1/4W	234 024 140
R26,33	10 ohm ± 5%, 1/4W	234 024 015
R28	390K ohm ± 5%, 1/4W	234 024 125
R29,30	5.6K ohm ± 5%, 1/4W	234 024 081
R34	33 ohm ± 5%, 1/4W	234 024 027

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
REM BOARD (A8)		**201 135 000 K**
CAPACITORS		
C1,4,5,8,15,17–20	.068 µf ± 15%, 50V	204 200 109
C2,16	1.0 µf ± 20%, 50V	204 121 082
C3	6.8 µf ± 10%, 35V	204 104 011
C6	.012 µf ± 5%, 50V	204 400 100
C7	.0033 µf ± 5%, 250V	204 400 077
C9	1 µf ± 20%, 50V	204 121 082
C10,11	68 µf ± 20%, 15V	204 600 012
C12,13	10 µf ± 20%, 25V	204 102 028
C14	.027 µf ± 5%, 50V	204 400 101
C21,22	.22 µf ± 10%, 250V	204 400 120
C23	.022 µf ± 20%, 50V	204 121 070
C24,27	.1 µf ± 20%, 100V	204 121 048
C25	1000 pf ± 15%, 100V	204 200 025
C26	.01 µf ± 20%, 100V	204 049 001
TRANSFORMERS		
T1	Transformer, Audio Output	202 900 016
T2	Transformer, R.F. Input	202 900 017
L1	Coil, Oscillator	202 900 020
SEMI–CONDUCTORS		
CR1	Diode, 1N4148	239 014 000
Q1	Transistor, #2222A	239 100 011
INTEGRATED CIRCUITS		
U1	LM13080N	210 400 005
U2	LM358AN	210 300 013
U3	4070B	210 210 070
U4	LM393N	210 300 011
U5	4093B	210 250 094
U6	4016B	210 210 016
U7	4013B	210 027 000
VR1	LM78M12CP +12V REG.	210 300 055
FUSE BOARD (A7)		**201 037 003 B**
CAPACITORS		
C1	2500 pf ± 5%, 1000V	204 300 106
MISCELLANEOUS		
F1,3,5,7,9,11,13	Fuse .5A, 125V GFA	215 100 027
F2,4,6,8,10,12,14	Fuse 3A, 250V 3AG	215 005 005
S1–3	Thermostat #2450–87–191	240 001 004

REFERENCE DESIGNATION	DESCRIPTION	VALLEYLAB PART NUMBER
CHASSIS ASSY (A9)		**200 500 033 H**
RESISTORS		
R4	Trimpot 500 ohm ± 10%, 1W	236 100 025
R5	250 ohm ± 3%, 50W	234 003 003
R6	56 ohm ± 3%, 25W	234 020 002
CAPACITORS		
C1	2400 µf ± 75%, 50V	204 500 025
C4	90 µf, 400V	204 119 132
C5	22K pf ± 5%, 500V	204 002 001
DIODES		
CR1	MDA3504	239 700 003
TRANSFORMERS		
T1	Transformer, Power	251 200 016
MISCELLANEOUS		
	Footswitch Connector Assy	202 198 000
	Power Cord Assy	202 400 223
	Air Deflector	222 499 000
	Volume Control	202 196 000
FRONT PANEL ASSEMBLY		**202 700 885 D**
RESISTORS		
R1, 2	250 ohm ± 10%, 2 1/4W	236 003 005
SWITCHES		
S1	Power Switch Assembly	202 700 048
S2	Pure/Blend Switch Assembly	202 700 049
S3	Footswitch Selector Assembly	202 700 050
MISCELLANEOUS		
DS1,2	Lamp, Cut/Coag Indicator	215 000 000
COOLER ASSY (A7)		**202 205 002 C**
	Fan Assy	202 700 846
	Heatsink Assy	202 203 002